Symposium—
Engineers in Management

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Volume 33, No. 6 June, 1954

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A Quick Look at This Issue

ENGINEERS IN MANAGEMENT

- **Engineers as Followers and Leaders . . .** A re-examination of the leadership facts of life shows there are three approaches that may be used in leading a group of engineers. They are autocratic leadership, democratic leadership, and free rein leadership. These concepts were used to develop two tests, one for leadership tendencies and the other for followership. To learn what sort of leadership you exert and in what followership group you perform best, read this article and take the test yourself. **Page 114.**

- **Growing a Good Executive Crop . . .** Four sound fundamentals are the basis of the successful management development program of Standard Oil Company (N. J.). Also important, says the author in an article beginning on **page 117,** is off-the-job training.

- **Bacon Said It First . . .** Read, talk, write was the gist of what he said, and industry authorities are still saying it to engineers who want to get ahead: Read more technical magazines and books; participate in your technical societies; learn to write better papers and reports. For some other good advice received in a PETROLEUM REFINER survey of top personnel men, turn to **page 118.**

- **Communications Make the Manager . . .** In the companion article above, engineers were told to communicate if they would succeed. In this one, you'll get some solid information on HOW to communicate. Turn to **page 119** unless you know the answer to these questions: Are you a goozler? Are your ducks lined up? Is your English telegraphic?

- **Engineering: The Profession with a Glittering Horizon . . .** Competition is on the increase for engineering talent. Though engineers have increased from 40,000 in 1900, to 130,000 in 1920, and to more than 500,000 today, the heightening demand persists. For an analysis of the present supply-demand ratio for engineers, and a studious look at the future, turn to **page 123.**

Suggestion Systems Are Incentive Plans . . . No doubt you offer incentives that will make people apply for a job, and other incentives that will keep them on the job. But what of the incentives that will make them want to work beyond the routine of the job? How many employes are on your payroll only because they can't afford to give up their service

→ Turn Page →

benefits? For some blunt language on a serious subject, turn to **page 110.**

These Capital Costs Considerations for a Petrochemical Project . . . Here is an article which discusses some of the reasoning behind the decisions concerning capital expenditure for a petrochemical plant. The three most common bases for the allocation of capital for plant construction are discussed. In addition, the effect of corporate income tax level on the payout period and on the type and kind of process to be used is covered in some detail. If you are interested in the factors involved in deciding whether a new plant will be built or an existing one expanded, then you will certainly want to read this article. **Page 127.**

Equilibrium K's by Nomograph . . . This is the most comprehensive nomograph ever developed for equilibrium K's. The range includes the light hydrocarbons, narrow-cut petroleum fractions and certain non-hydrocarbons from 40 to 800 F. at pressures up to 10,000 psia. The average deviation from experimental data is 6.8 percent. **Page 131.**

How to Predict True Volumes in Blending . . . The importance of predicting volumetric changes when blending gasoline has been brought to the fore many times in the past. Small changes can and do have economic significance. This article presents a resume of past works on this subject, together with some new calculation methods developed by the author. **Page 137.**

The Chemical Industry Looks at LPG . . . Because of the variety of raw materials that can be used to produce the multitude of products by this industry, it is important to take a good look at present and future consumption of LPG. If it is high in price or short in supply, then steps must be taken to assure raw material supplies from other sources. As is pointed out, however, conditions are such that demand and use of LPG by the chemical industry is expected to see a tremendous increase in the next few years. For more information, see **page 141.**

Foundations for Self-Supporting Towers . . . Many designers are still following antiquated procedures in foundation design, when the current A.C.I. building code permits considerable economies in structural steel. Here is a practical, working article that carries the reader through several calculations and examples to demonstrate how these savings can be realized. **Page 145.**

Reduce Clay Dosages by 50 Percent . . . This study shows that major reductions in clay requirements for contact decolorization of lubricating oils can be made by first distilling lube oil stocks into light and dark fractions. In one case cited clay requirements were reduced from 7 to 3.5 pounds clay per 100 pounds oil. **Page 149.**

Air-Cooled Industrial Heat Exchanger . . . The past 15 years have been the greatest period of development of air cooled heat exchangers using mechanical air circulation. Because of the developments made, installations costing $100,000 are quite common today, and one plant, completed last year, contains air cooled heat exchange equipment costing $1 million. A review of these developments begins on **page 151.**

Petrochemical Reactions, Polymerization of Olefins . . . The mechanism of the polymerization reactions and the various types of techniques used in the production of these highly important products are covered in detail. Reaction conditions required for the production of such products as polyethylene, polybutene and polystyrene are clearly defined. **Page 155.**

Adsorbents and Catalysts . . . The design engineer can determine capacities, pressure drops, bed temperatures and optimum particle size for solid beds by the use of the physical properties of adsorbents and catalysts presented in this article. The authors have made available in one place the data which more often than not has to be obtained through several published articles. **Page 159.**

Designing Fired Tubular Reactors . . . This is the second article by these authors on the same general subject. In the first, which appeared in the March, 1954, issue the approximate design or shortcut method was developed. This article discusses the practical application of the method of designing a new reactor and how the method can be used to predict the behavior of an existing reactor. **Page 163.**

Experience With Amine Units . . . If your amine units for H_2S removal are still giving trouble, check the ten design hints and five operating hints outlined in this article. Significant reductions in corrosion, amine losses and operating upsets have been made by this company. **Page 167.**

Water Problems and Their Solutions . . . The second in this water handbook series brings you up-to-date on what water analysis means. The author takes up each ion—telling how it gets in the water, how it is removed and why it is important. **Page 169.**

Avoiding Underground Corrosion . . . Cathodic protection is recognized as an effective method of corrosion mitigation. The increasing use of this method is, however, increasing the complexity of existing problems. Take a look at **page 172** for some unique solutions to these problems and for a valuable addition to your corrosion library.

Corrosion Investigating Techniques . . . It has been only recently that the operators have begun to find out what the problem of corrosion is costing in gasoline plants. The problem has always been there. The operators have always lived with it. And yet, in most cases, there have not been sufficient records kept to tell the whole sad story. This paper presents a discussion of the "tools" that can be used by the engineer in making an investigation of an existing or a potential corrosion problem and in evaluating the merits of inhibitors or other corrective measures. **Page 176.**

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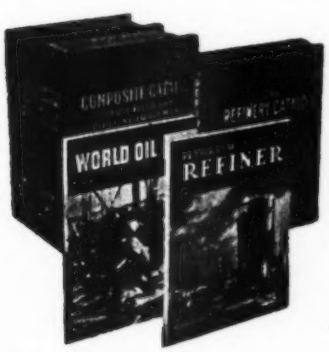

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Bob's B. S. & W.

Something Special for the Engineer. As noted in this column before, it gets mighty tiresome listening to the grunts and groans of people who regard engineers as intellectual introverts with heads buried in technical texts. We got so tired of it in fact, that we cooked up a very special symposium on the theme of "Engineers in Management." Under the guidance of our very capable Al Reese, one of the most talented writers in the business, we believe that this roundup of articles will give you a real push in the direction you're heading—Top Management. The Symposium begins on page 114.

★ ★ ★

Sage Saying of the Month: *The dollar won't do what it used to for people, but then people won't do what they used to for a dollar.*

★ ★ ★

Take a Quick Look at an innovation we introduced to the publishing business. Beginning on the contents page and continuing on the next page, we have a feature entitled "A Quick Look at This Issue" in which the meat of every article is highlighted to aid you in making your reading choices. It would be mighty nice to think that you read each and every word of each and every article, but being practical souls, we know this isn't likely. Being even more practical, we know that you're busy, so why don't you lean on this little crutch in making your reading decisions? You can depend on the honesty of these little summaries.

★ ★ ★

Making the Most of a Situation. The Fort Worth refinery of Premier Oil Refining is located smack dab in the middle of a bustling suburban section and on the edge of one of the city's busiest thoroughfares. So when the company built a new cat cracker, they decided to capitalize on what could easily have been quite a disadvantage.

A mighty fancy control room, completely glassed in, and the last word in modern architecture, faces directly on the busy street. A beautifully landscaped driveway is being provided for passersby to pull off the highway and watch a modern refinery in action. **The fact that nowadays operators spend a high percentage of their time just sitting and watching instruments may rob the scene of drama, but presumably this alert management will think of something to entertain the customers.** P.S.: Needless to say, tobacco chewing and nekkid women calendars had to go!

★ ★ ★

Additives—Fact or Fiction? There has been a great deal said, and somewhat less done, about the pre-ignition problem and the place of additives in solving it. The two extremes: (1) additives are the answer, and the only answer vs. (2) additives currently in use are not the answer and in fact, may cause more harm than good. The function of a good aggressive technical magazine is not to duck controversies, but rather to bring all the *facts* out in the open and let the readers make their own choice. We're going to do just that in an early issue.

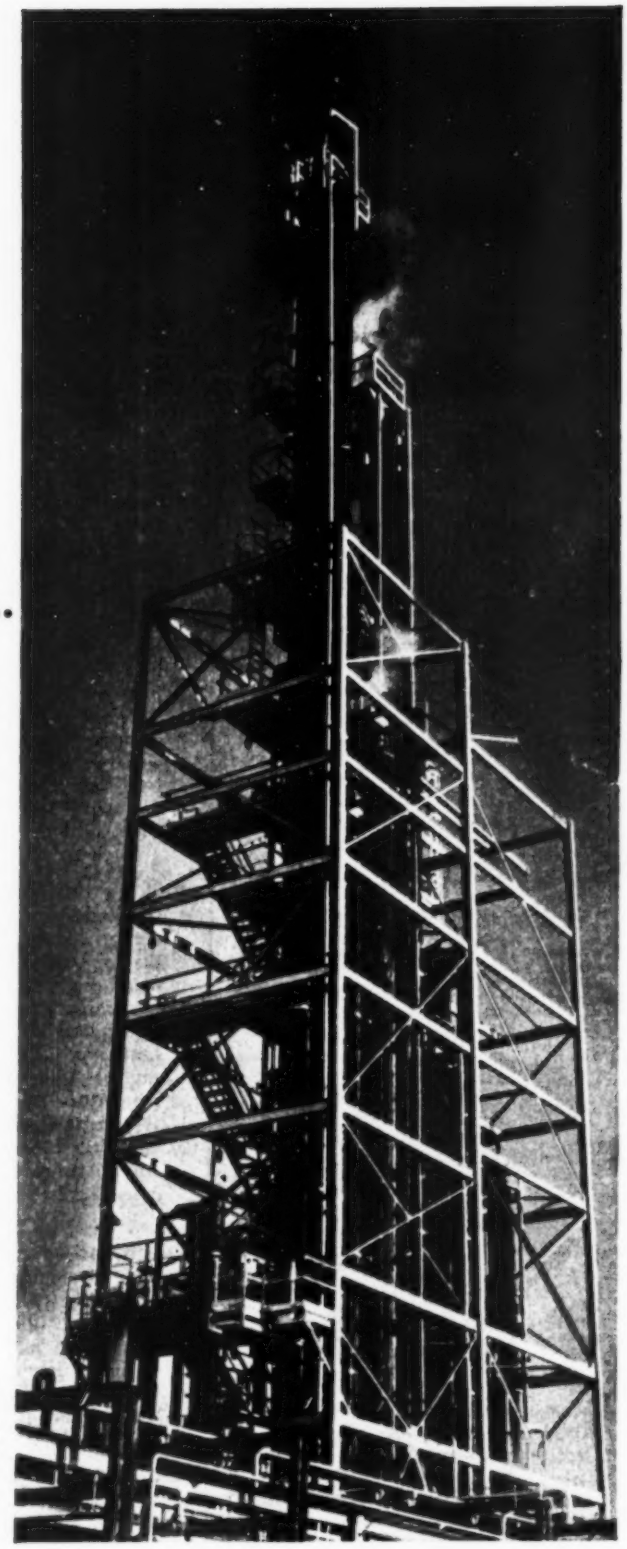
★ ★ ★

Latest Hydrogen Bomb Appraisal: Sweeping away the cobwebs of secrecy, one scientist has released these details on the three sizes of H-bombs now available:

1. Small
2. Medium
3. Where Is Everybody?

—*Bob Phillips*

Making pure Ethylene from Raw Gas



Here, silhouetted against the sky, are giant distillation and absorber towers in the new Canadian Industries Limited Plant at Edmonton, Alberta. Since late last year this plant has been producing highest purity ethylene from natural gas for use in the manufacture of polyethylene.

These operations involve the recovery of ethane from dry gas by absorption at elevated pressure in a "sponge oil." This "sponge oil" is then stripped of its ethane content which in turn is "cracked." The resulting ethylene is then compressed, dried, separated and purified by fractional distillation at 500 p.s.i., and stored under pressure as a liquid.

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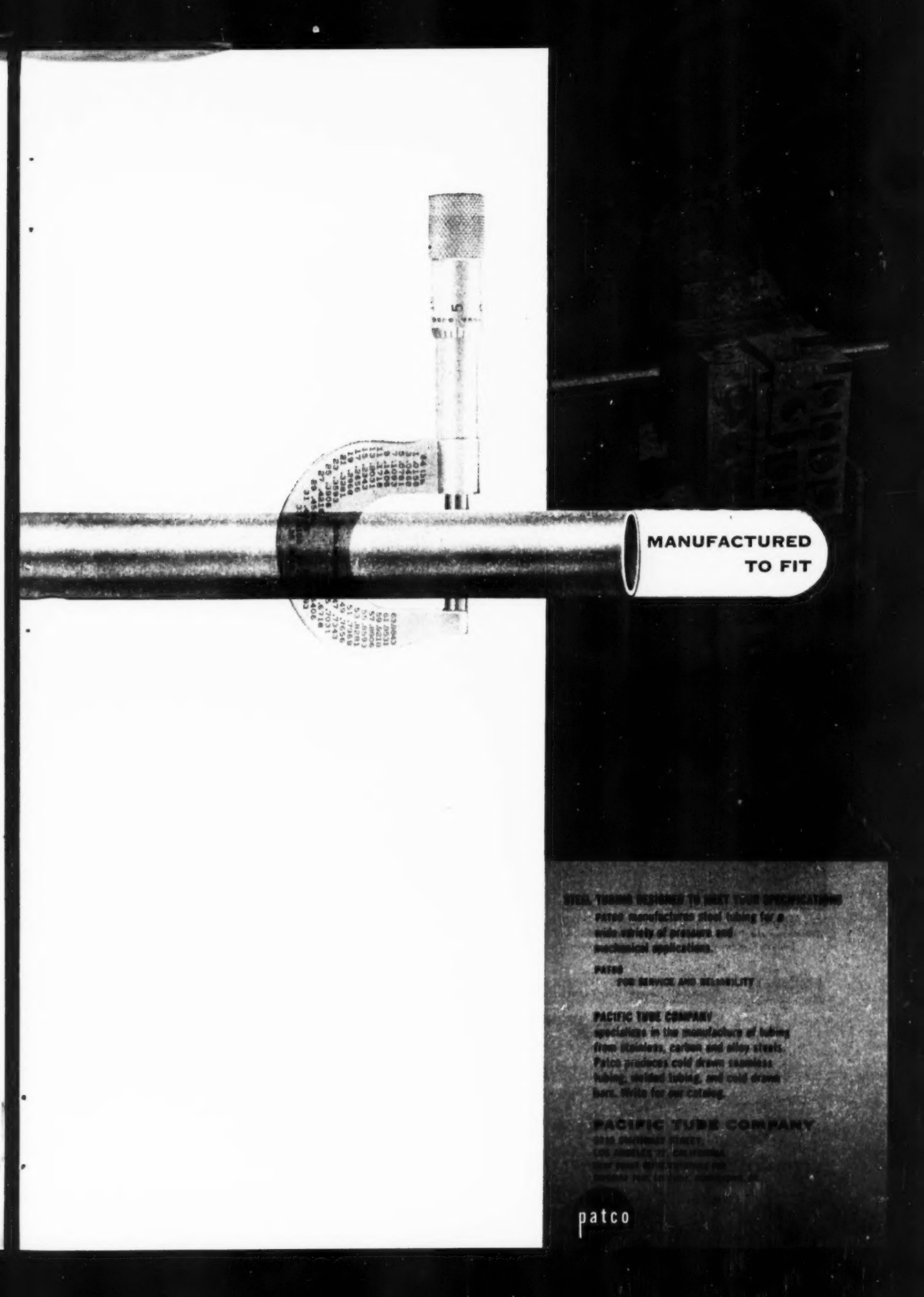

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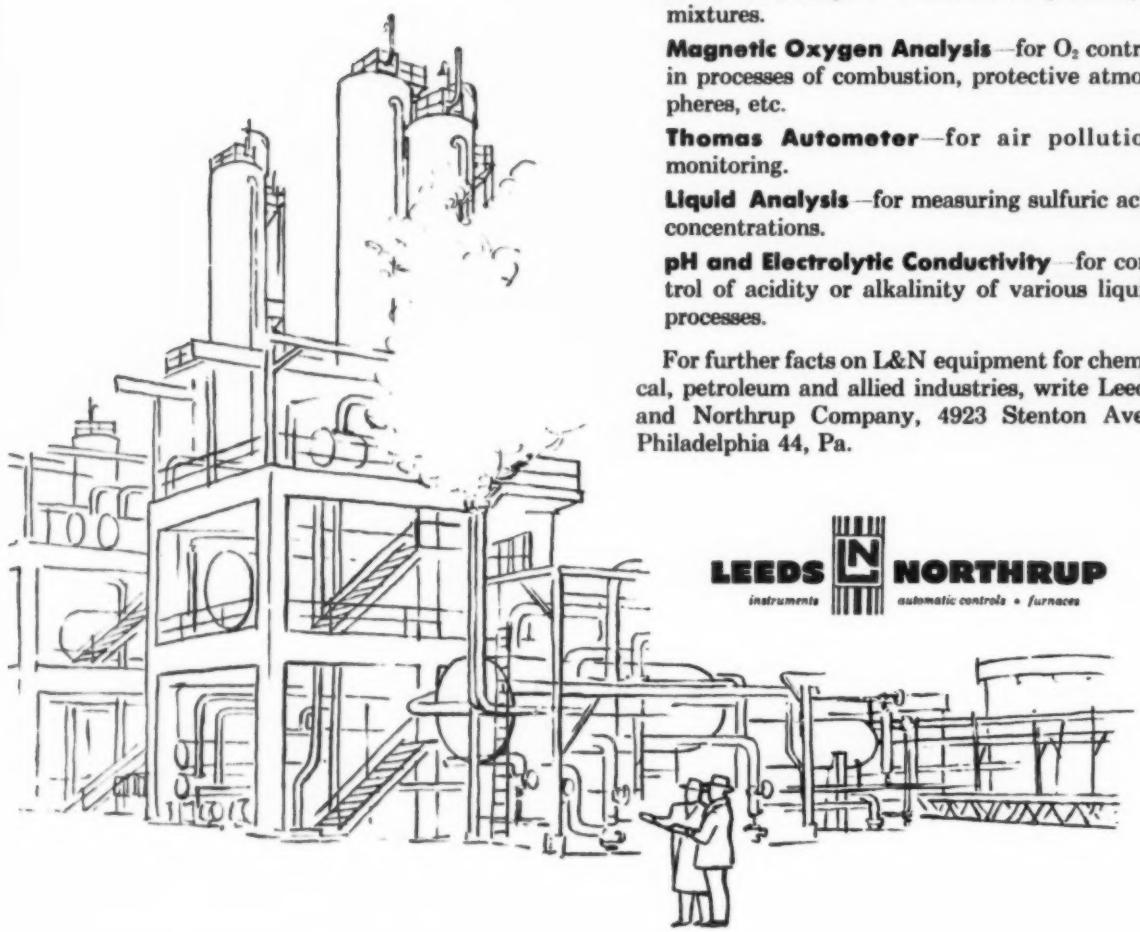

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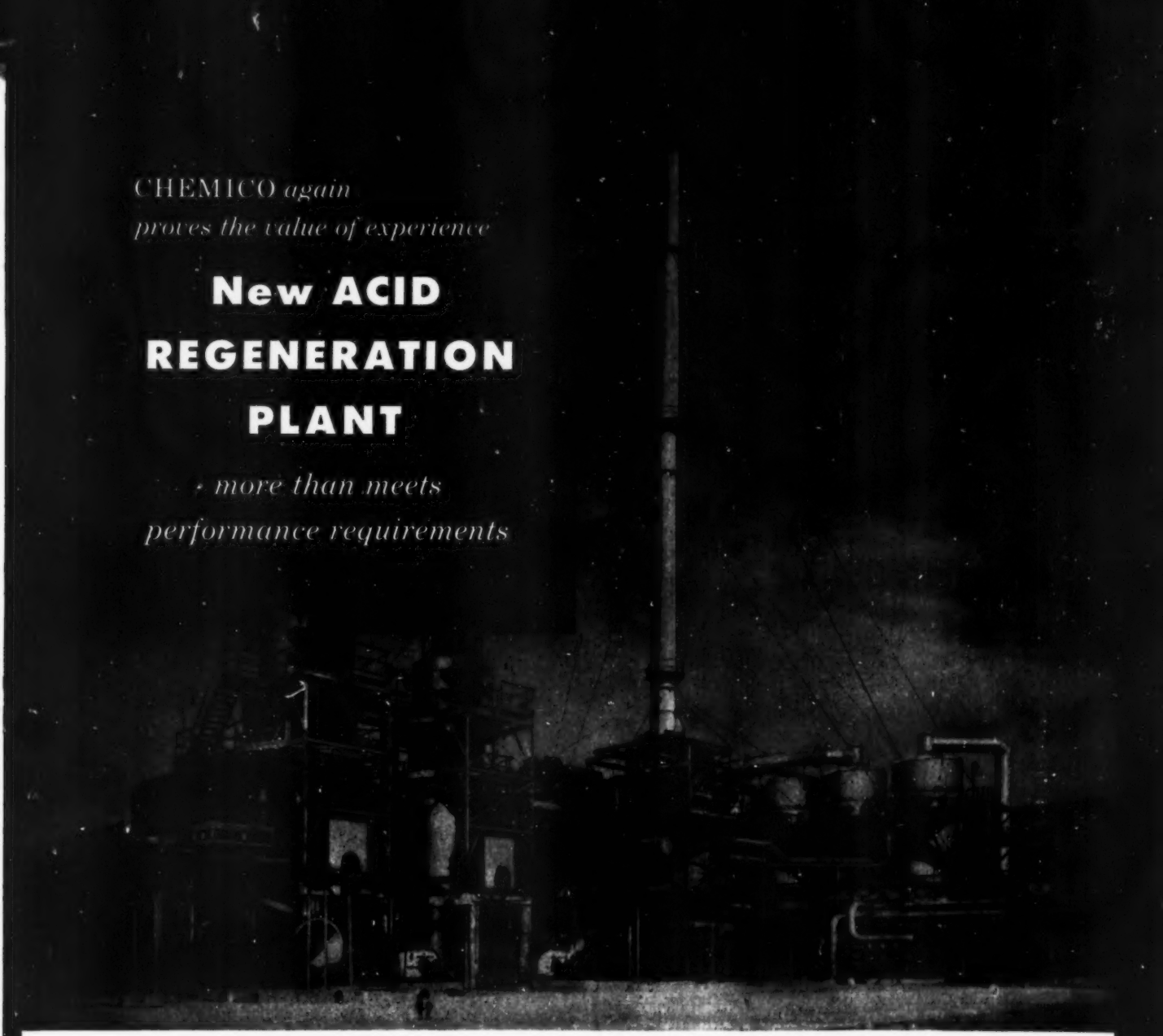

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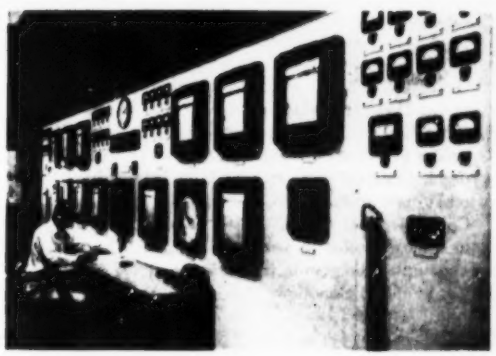

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- Victor Chemical Works
- Westinghouse Electric Corp.

WRITE FOR CATALOG LB-1, "PORTENT OF THINGS TO COME"

CC 400

CONOFLOW CORPORATION

FOREMOST MANUFACTURERS OF FINAL CONTROL ELEMENTS

2100 ARCH STREET, PHILADELPHIA 3, PA.

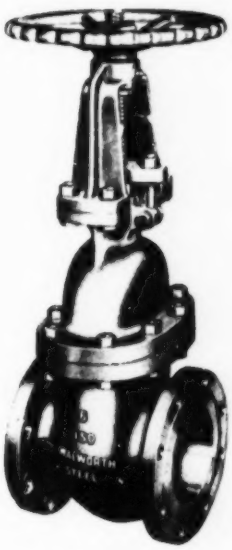
VALVES FOR 100 YEARS!

Walworth cast steel gate valves are as standard with J&L stores as nails in a lumber yard.

The comparison ends there. In sharp contrast with nails, for which there are no rigid standards, Walworth valves never vary in quality and the quality is never anything but tops.

Walworth has made valves since 1842; valves of steel, iron, bronze, and special alloys; valves for all conventional and many unusual uses. We welcome inquiries about valves in these latter categories.

The nail you try to drive may bend, but a Walworth valve will never let you down. Anything that flows through the veins of the petroleum industry will STOP or GO or SLOW DOWN as you direct with a Walworth.



Walworth
OS&Y Gate

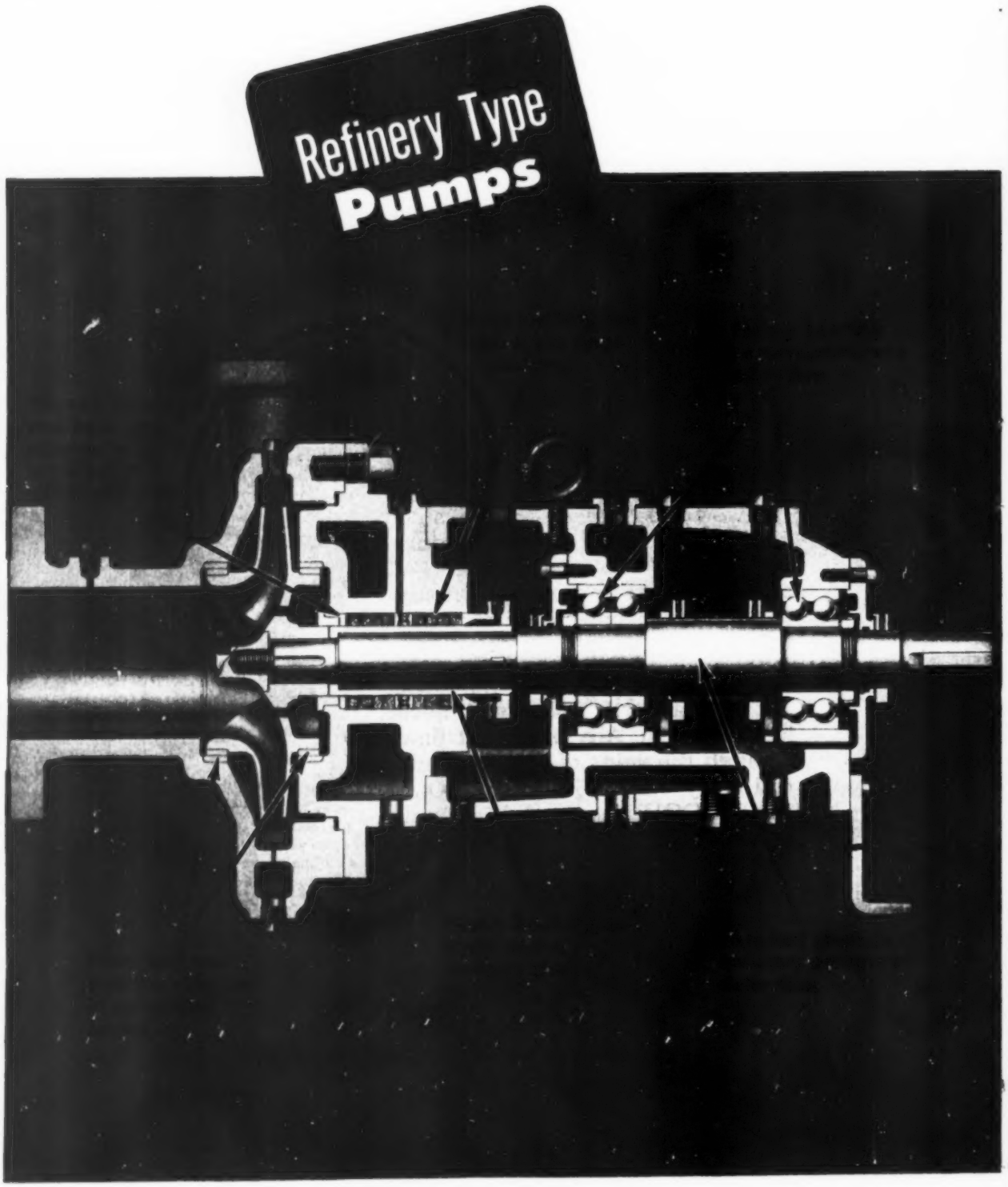
J&L STEEL

P·E·S·A
PETROLEUM EQUIPMENT SUPPLIERS ASSOCIATION
PARTNERS IN PETROLEUM PROGRESS

Jones & Laughlin
STEEL CORPORATION
SUPPLY DIVISION —— TULSA
Serving The United States and Canada

For more data on advertised products, use Readers' Service Cards, last page.

EXTRA heavy-duty construction



For more data on advertised products, use Readers' Service Cards, last page.

gives you

service continuity

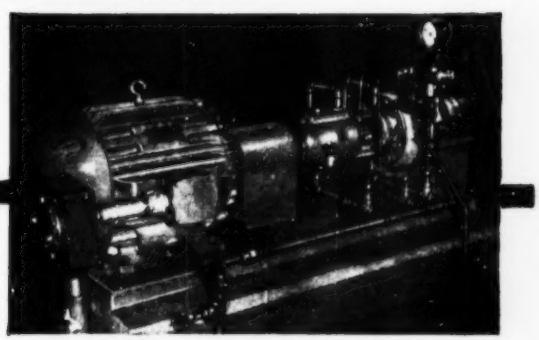
WHERE A STOPPAGE COSTS A FORTUNE, install Allis-Chalmers Refinery Pumps. These pumps have the stamina to keep going on the toughest applications for years without rest. Every construction detail, those shown here and many others, has been carefully engineered to provide ample reserves of strength and durability. Careful workmanship and expert application engineering make these pumps deliver all the reliability that is designed into them.

Wide Choice of Materials, Features

The Allis-Chalmers Refinery Pump can be fitted to suit your requirements exactly. Practically any material normally used in pumps may be specified. Stuffing box takes packing, mechanical seal or both. Cooling water or oil may be used in five separate places so you can select exactly the cooling arrangement for your particular needs. Suction may be at top or on end.

Get Complete Information and Engineering Help

Your nearby Allis-Chalmers representative will be glad to help you with your refinery pump problems. Or write for Bulletin 52B7775. Allis-Chalmers, Milwaukee 1, Wisconsin.

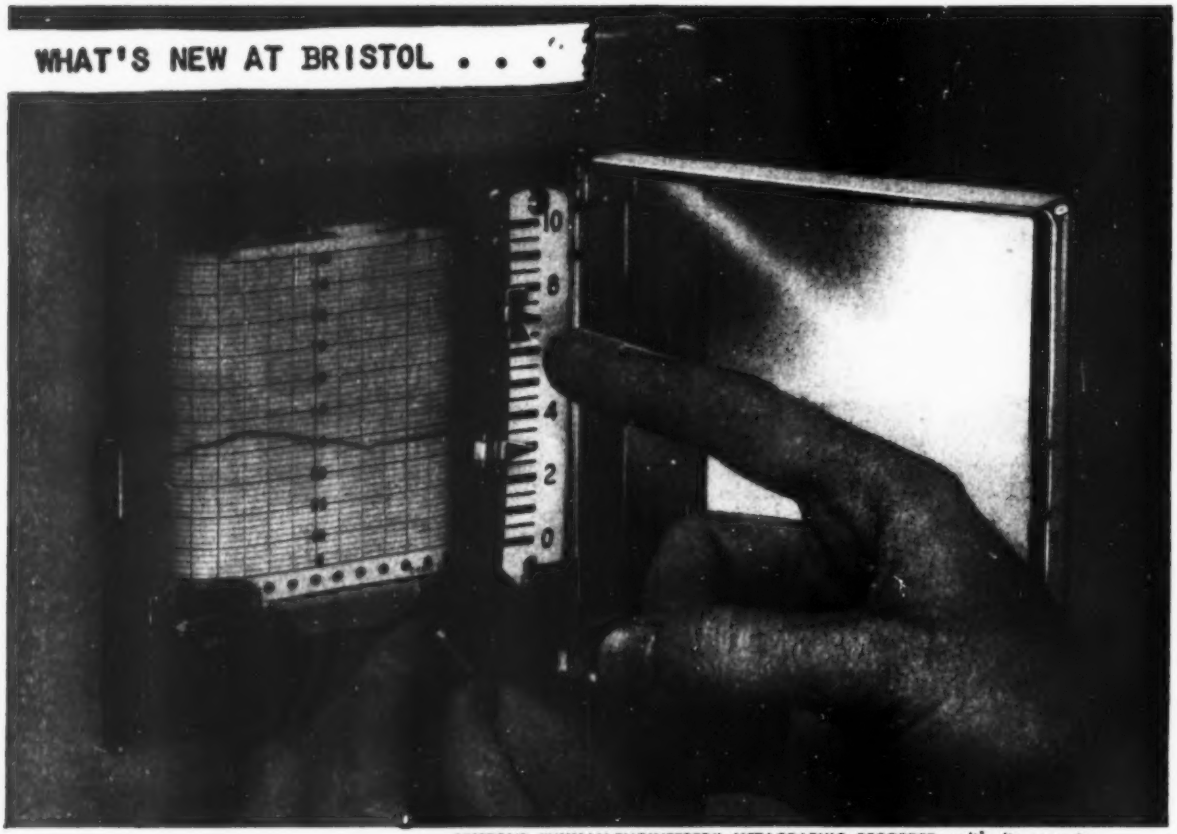


Save Engineering and Installation Time with an Allis-Chalmers Pump Package

Allis-Chalmers will supply a complete pumping unit — pump, motor and control — engineered to work together and with pump and motor mounted on a single base plate ready for installation. You save engineering time because you don't have to match components from different manufacturers. You save installation time because the unit comes to you already assembled. And, most important, you are sure that the components will work together to give you long life at low operating cost. The complete unit is covered by a single guarantee backed by Allis-Chalmers well-known customer satisfaction policy.

A-4333

ALLIS-CHALMERS



BRISTOL'S "HUMAN-ENGINEERED" METAGRAPHIC RECORDER, with its easy-to-read scale, high-visibility fluorescent pointers and shadow-proof door has earned the distinction of being the "biggest little instrument in the business."

Instrument men call Bristol's METAGRAPHIC Recorder

"... the biggest little instrument"

Sounds contradictory, but it's true. Take a look at one of our new METAGRAPHICS mounted on a panel board alongside of other instruments. The Bristol unit stands out – seems bigger than the rest – although chances are it's actually smaller (5" x 5¾"). The answer is that the Bristol instruments have been "human-engineered", making them easy to read, and clearly visible at greater distances.

The air-operated METAGRAPHIC, which records pressure, temperature, vacuum, flow, differential pressure, and liquid level, offers these big advantages:

SIMPLICITY . . . fewer moving parts, fewer adjustments, and less service required. Range changes can be made in seconds. True plug-in service.

CONTINUOUS VALVE-POSITION INDICATION . . . on same instrument scale as set-point scale, gives continuous data on control valve position—makes "bumpless" transfer possible simply by matching pointer positions – no need to read actual scale values – minimizes reading errors – speeds operations.

CONTINUOUS OPERATION . . . complete unit can be retracted for inking pen, and for set-point and zero adjustment without disturbing record or control.

Get the whole story on the "human-engineered" METAGRAPHICS – how they can help you get more accurate measurements, faster and easier. Write us today. The Bristol Company, 111 Bristol Road, Waterbury 20, Conn.

4.4

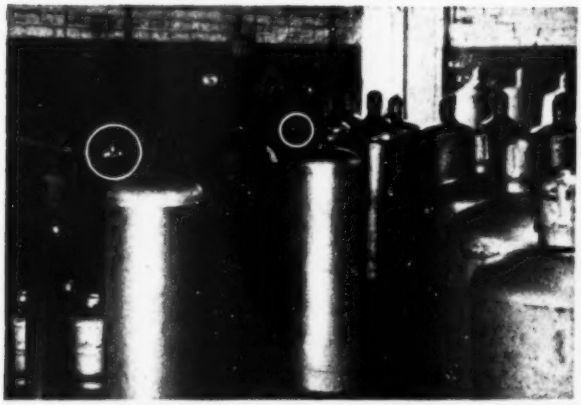
BRISTOL

POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION

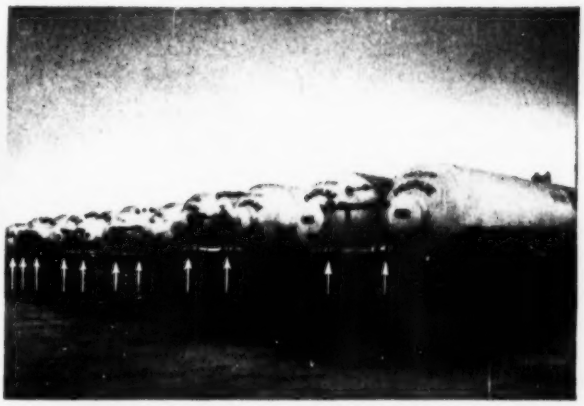
AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more data on advertised products, use Readers' Service Cards, last page.

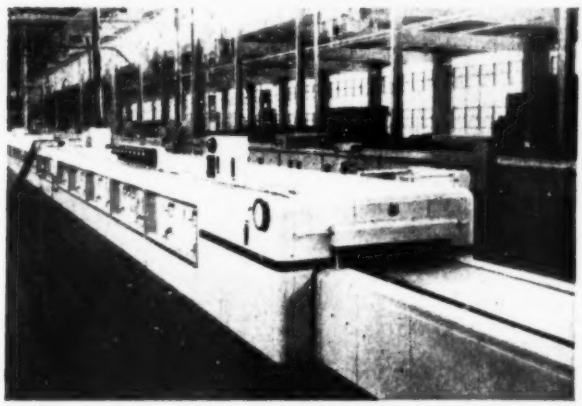
Do you need a LEAKPROOF VALVE?



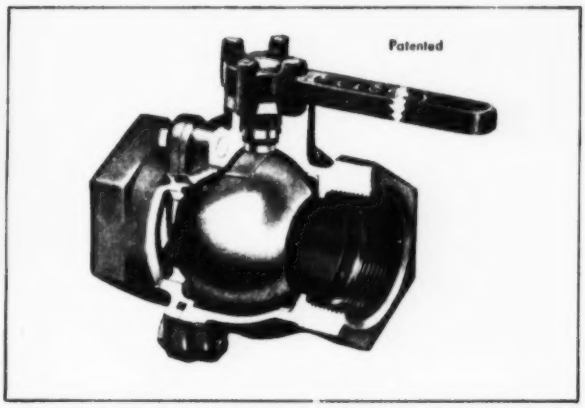
Leakproof in a Propane Plant, where hazards are high and protection is important. Here Rockwood Ball Valves are "far ahead of any others we have used," to quote the maintenance engineer.



Leakproof on LP Gas Trucks, where a whole fleet of trucks carries flammable bottle gas. Operator of fleet reports longer life for valves and generally lower costs since standardizing on Rockwood Ball Valves.



Leakproof in a Bakery where escaping gas and gas odor are a hazard. Rockwood Ball Valves, used in the ovens above, hold tight despite adjustment at various times to control flow of natural gas.



Leakproof for Longer Time — because Rockwood Ball Valves are designed to operate under the roughest and most grueling of conditions. They pay for themselves over and over wherever they are in service.

Plus these other exclusive features

Full Round Flow — assuring fast, efficient operation, less friction loss.

Quick Opening and Closing — needs only ¼ turn even under full pressure.

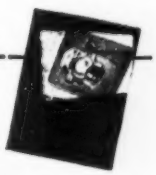
Resists Wear Longer — Chrome-plated bronze ball stands up under abrasion, pitting and scratching.

Rockwood Ball Valves are used in all types of applications throughout the petroleum field. Perform with trouble-free continuity. Longer time between replacements, less maintenance on the job. Comes in all pipe sizes. Tested and listed by Underwriters' Laboratories, Inc. The coupon will bring you complete information.

ROCKWOOD

THE FLOW IS AS ROUND AS THE PIPE ITSELF

***FULL-FLOW* BALL VALVES**



ROCKWOOD

ROCKWOOD
SPRINKLER COMPANY
566 Harlow Street, Worcester 5, Mass.

Send me illustrated folder V-4 on Rockwood Full-Flow Ball Valves.

Name.....

Title.....

Company.....

City.....

Zone..... State.....

For more data on advertised products, use Readers' Service Cards, last page.

K&M

"CENTURY" APAC

ASBESTOS-CEMENT SHEETS

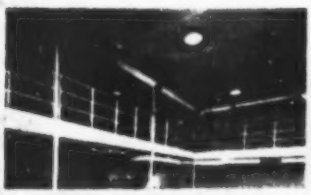
Last Long, Look Cost Little

No matter what your building plans, the chances are you can profitably use "Century" APAC sheets.

Being made from asbestos fiber and portland cement, APAC is fully resistant to fire and weather, rats and termites. Thus it serves equally well indoors or out—for walls, ceilings, liners, and partitions. Although its smooth, attractive surface takes decorative colors well, it doesn't require paint for protection—ever!

When it comes to cost, "Century" APAC is even more outstanding! It's made in 4′ x 8′ sheets that are easy to handle, easy to cut and drill, easy to apply with ordinary tools. This ease and speed of application does more than save you labor costs, too! APAC helps get new facilities into production faster; helps you to modernize existing structures without prolonged disruption of the work routine.

Your K&M distributor will gladly give you further details on versatile "Century" APAC sheets. Contact him soon, or write to us direct.



KEASBEY & MATTISON COMPANY • AMBLER • PENNSYLVANIA

Nature made asbestos . . . Keasbey & Mattison has made it serve mankind since 1873

K&M best in asbestos

News from down on the farm

It wasn't so long ago that most tractor dealers harvested a growing crop of complaints about valve failures every season. Now complaints about valve burning are becoming as rare as buckboards.

Why?

To make a long story short: Back in 1950, an Ethyl survey of 12,000 tractor dealers disclosed that valve burning was becoming increasingly serious. And, even though this was largely a mechanical problem, petroleum refiners and marketers also were concerned because they were hearing about it from their customers.

We knew that valve rotators had successfully prevented valve burning in heavy-duty trucks—and would be equally effective in tractor engines. So, as a service to the petroleum industry, we decided to tell tractor manufacturers, dealers and farmers of our experience.

(Continued on next page)

Printed in U.S.A.

News from down on the farm

(*Continued from preceding page*)

We organized an educational program promoting valve rotators. Nearly half a million rotator booklets were distributed and Ethyl valve-rotator films toured the country. Ethyl demonstration trailers followed through with complete information on valve-train servicing, installation methods and the like. And, of course, strong advertising was placed in tractor trade publications.

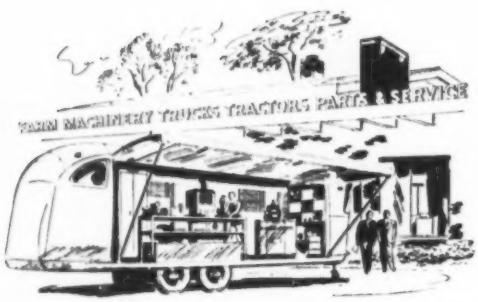
Result: Today, rotators are available at the factory for more than three-quarters of the tractors produced. (Only one model could be so equipped in 1950.) And more than 95% of all tractors made since 1939 can now be equipped with rotators.

MOST IMPORTANT, VALVE BURNING IN TRACTORS IS NO LONGER A PROBLEM.

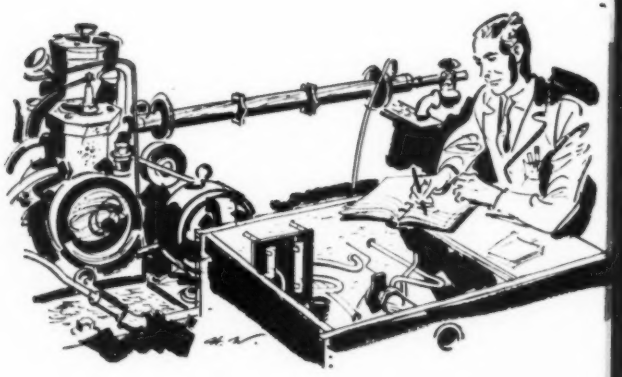
This is another example of how Ethyl's unique position in the industry enabled us to perform a valuable service and protect an important petroleum market.

ETHYL CORPORATION
NEW YORK 17, NEW YORK

WORTH NOTING



Streamlined mobile classrooms have proved a most effective Ethyl service tool in providing on-the-spot instruction in precision service of tractor engines.



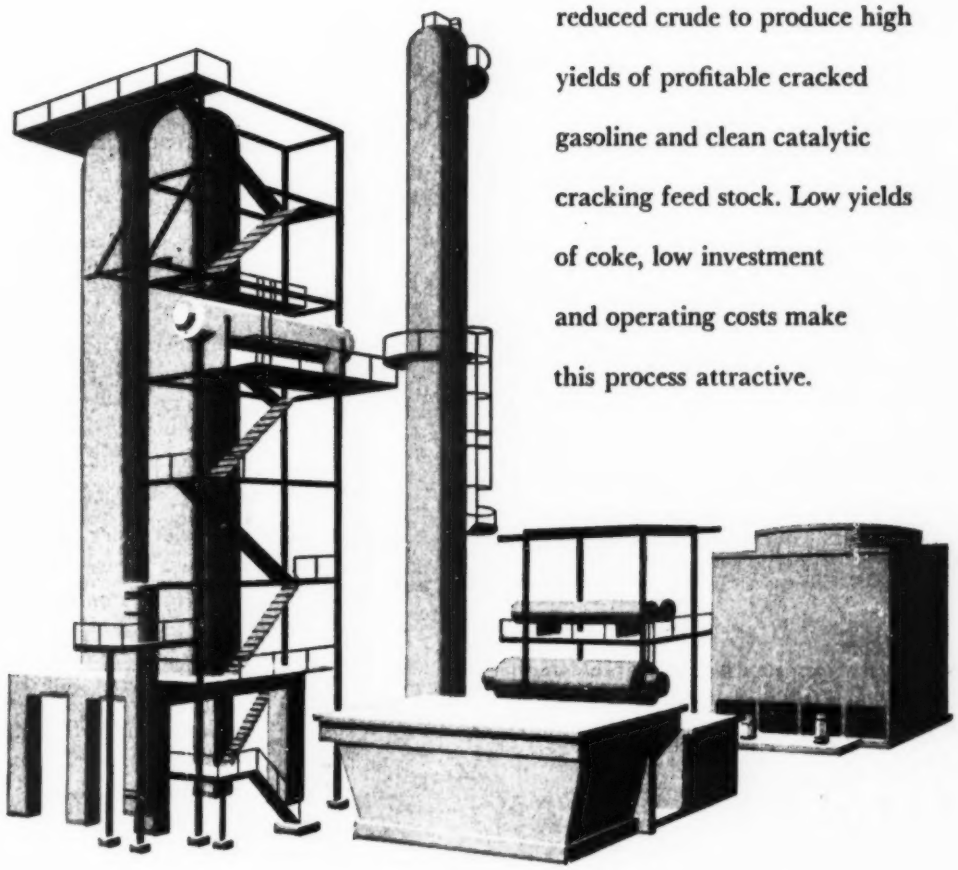
Invisible particles in engine exhaust gases are trapped in this electrostatic precipitator to help Ethyl research people develop better antiknock compounds.

Your best gasoline will be promoted to motorists beyond the reach of Ethyl's television program by minute movies in more than 350 selected drive-in theatres.

Ethyl Service is backed by 31 years of antiknock experience

Blaw-Knox decarbonizing process

. . . a simple means of processing reduced crude to produce high yields of profitable cracked gasoline and clean catalytic cracking feed stock. Low yields of coke, low investment and operating costs make this process attractive.



BLAW-KNOX

BLAW-KNOX COMPANY

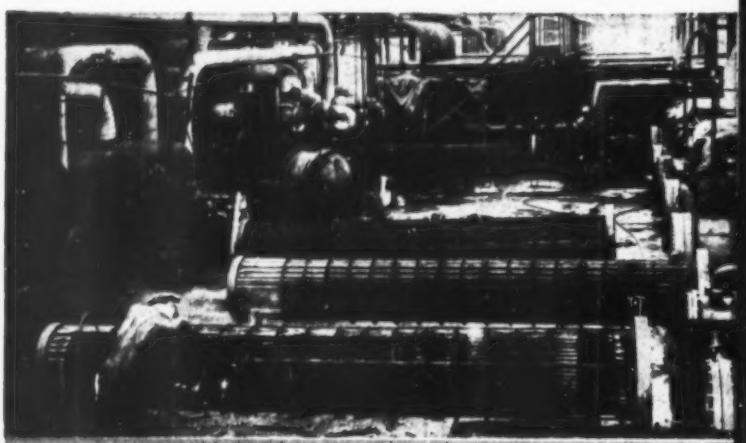
Chemical Plants Division

Tulsa 1, Oklahoma

Pittsburgh 22, Pennsylvania / Chicago 1, Illinois

For more data on advertised products, use Readers' Service Cards, last page.

CORROSION AND FOULING PROBLEMS?



Over 150 leading refiners are now using Kontol Corrosion Inhibiters to combat corrosion and fouling in their refinery equipment*. Successful Kontol applications have corrected corrosion and fouling problems in lines and equipment of these refinery processes . . . . . .

KONTOL PROVIDES PROVED ANSWERS

Crude Stills

Depropanizers

Debutanizers

Depentanizers

Gas Plant Absorbers

Cat Cracker Fractionators

Stabilizers

Platformers

Reformers

Vacuum Towers

Desulfurization Systems

Gas Recovery Systems

Coking Systems

Alkylation Plants

Alkanolamine Sweeteners

Dewaxing Systems

*

While Kontol is best known for the protection afforded to carbon steels, it is also effective with alloys such as admiralty metal, cupra-nickel, stainless and others.

If you have a corrosion or fouling problem, get in touch with the Tretolite refinery service engineer in your area, or write to

TRETOLITE COMPANY

A DIVISION OF PETROLITE CORPORATION

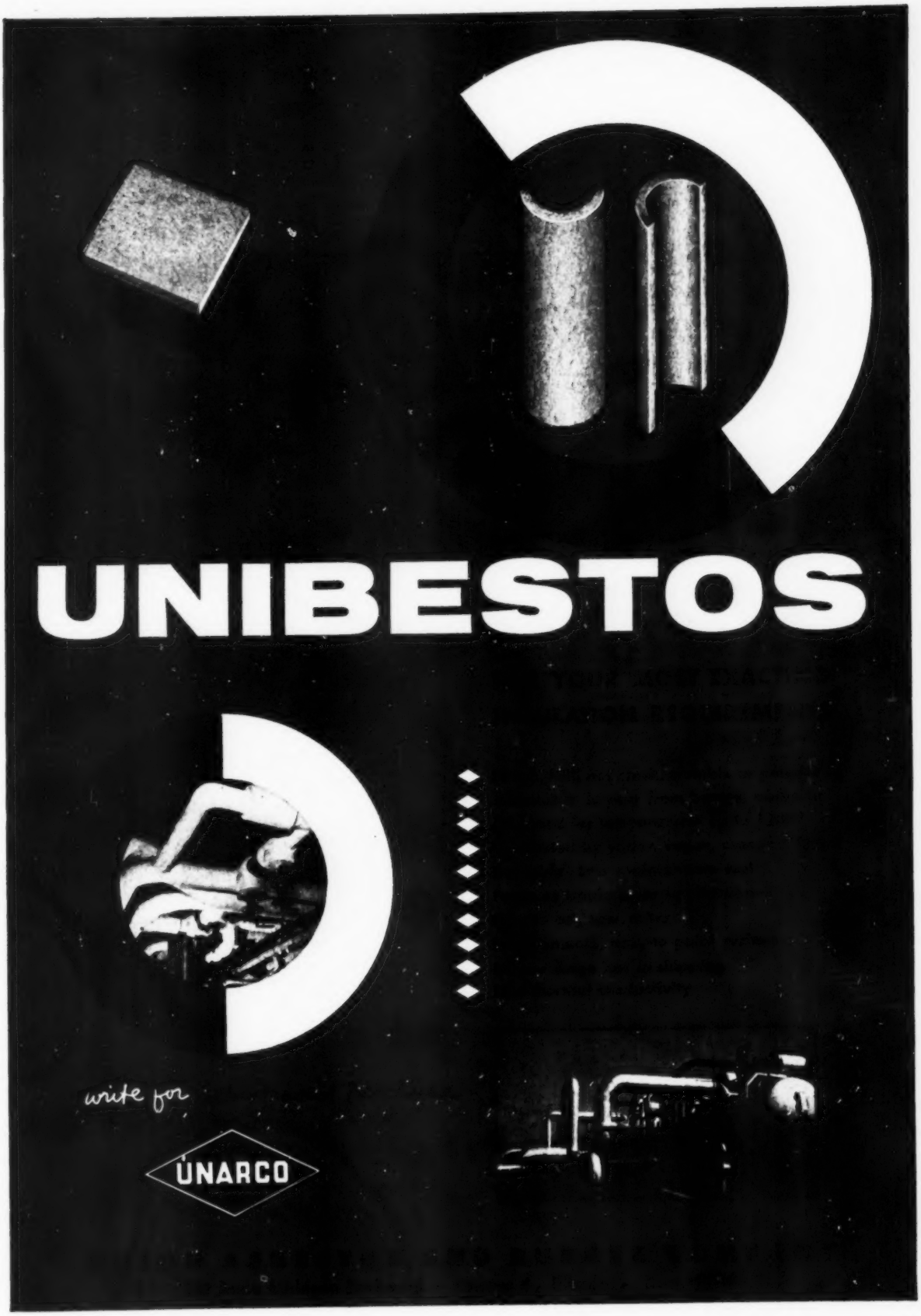
369 Marshall Avenue, St. Louis 19, Missouri

5515 Telegraph Road, Los Angeles 22, California

DESALTING • DEHYDRATING • WATER DE-OILING • CORROSION INHIBITORS • SCALE PREVENTIVES • ASPHALT ADDITIVES

KR 54-12

For more data on advertised products, use Readers' Service Cards, last page.


UNIBESTOS
write for
UNARCO

DUAL METAL

What is "dual metal"?
Depends on what business you're in!

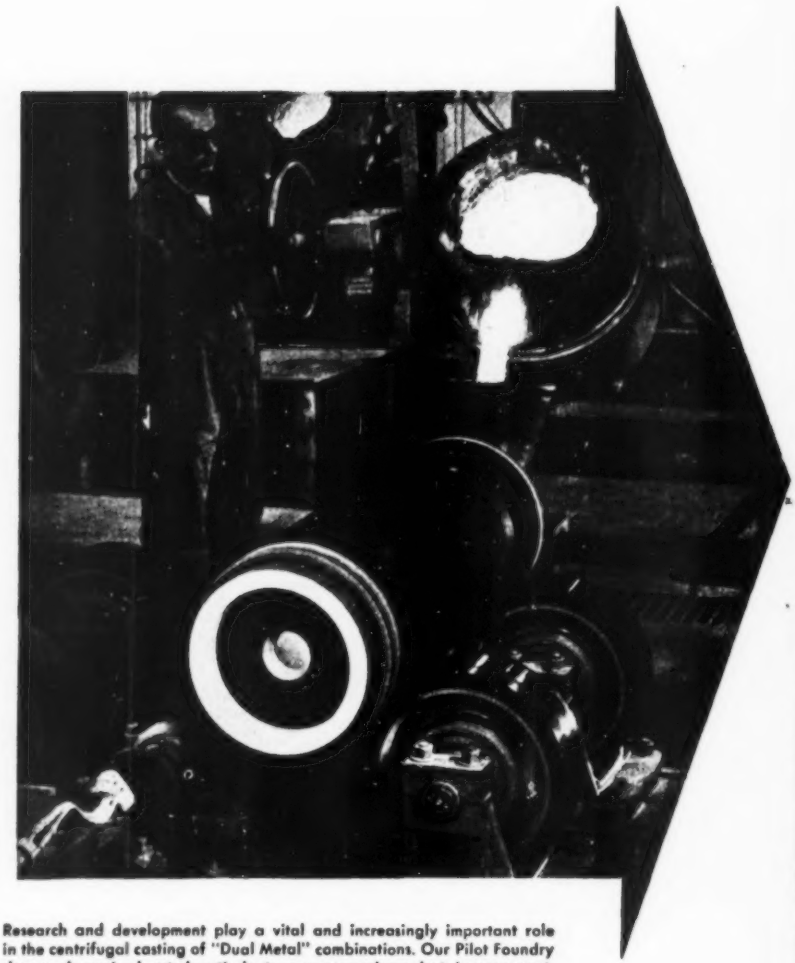
To twenty of America's largest basic industries with problems of abrasion or corrosion—or both—"Dual Metal" means U. S. Pipe's Special Products Division.

Specifically, "Dual Metal" is our name for centrifugally cast cylindrical sections in which two dissimilar metals are bonded metallurgically by centrifugal force and temperature.

"Dual Metal" centrifugally cast, integrally fused combinations of two dissimilar metals are doing industry's most difficult and exacting jobs better and more economically than ever before.

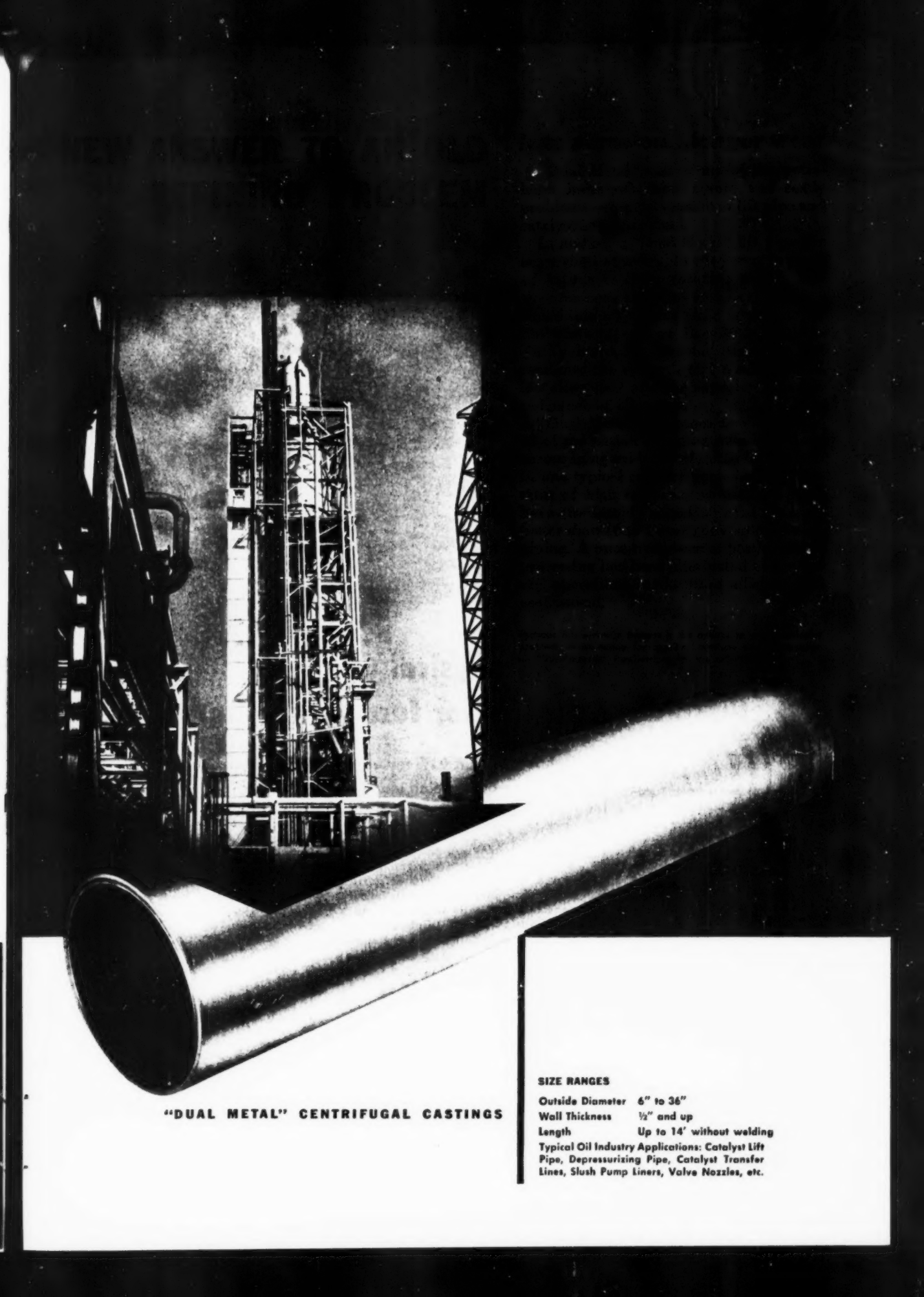
Design engineers have been quick to recognize the outstanding merits of a process capable of combining the desired mechanical and chemical properties no single metal possesses.

"Dual Metal" means versatility, efficiency and economy.



Research and development play a vital and increasingly important role in the centrifugal casting of "Dual Metal" combinations. Our Pilot Foundry shown above is devoted entirely to process and product improvement.

SPECIAL PRODUCTS DIVISION
U S P



"DUAL METAL" CENTRIFUGAL CASTINGS

SIZE RANGES

Outside Diameter	6" to 36"
Wall Thickness	½" and up
Length	Up to 14' without welding

Typical Oil Industry Applications: Catalyst Lift Pipe, Depressurizing Pipe, Catalyst Transfer Lines, Slush Pump Liners, Valve Nozzles, etc.

Johns-Manville announces the development of new **SIL-O-CEL 16L** *Insulating Fire Brick...*

Lompoc, California, where Johns-Manville mines and processes diatomaceous silica insulating materials

Combines outstanding physical and thermal properties for furnace service to 1600F

Check these properties of SIL-O-CEL 16L

Maximum service temperature	1600F, back-up or exposed
Approximate density	33-35 lb per cu ft
Transverse strength	60 psi
Cold crushing strength	330 psi
Linear shrinkage	0.7 percent at 1600F
Reversible thermal expansion	less than 0.1 percent at 1600F
Thermal conductivity (Btu in. per sq ft per F per hr at indicated mean temperatures)	0.92 at 500F 1.07 at 1000F 1.22 at 1500F

1—has less than 0.1% reversible thermal expansion at 1600F

2—provides high load-bearing strength

3—for direct exposure or back-up service

Here is a new development of Johns-Manville insulation and refractory research. Its exceptional characteristics provide important savings in furnace construction. Made of diatomaceous silica, Sil-O-Cel* 16L Insulating Brick is light in weight . . . has low thermal conductivity . . . high structural strength. And where furnace linings are subjected to severe heat shock or where high load-bearing properties are needed, Sil-O-Cel 16L offers outstanding performance.

Sil-O-Cel 16L is now available. Samples will be sent on request. Also available without obligation is Booklet IN-115A, which describes Sil-O-Cel 16L and other J-M Insulating Brick and Insulating Fire Brick for service to 3000F. Write Johns-Manville, Box 60, New York 16, N.Y. In Canada, 199 Bay Street, Toronto 1, Ontario.

*Sil-O-Cel is a Johns-Manville registered trade mark

Replaces SIL-O-CEL Natural Brick

The development of Sil-O-Cel 16L Insulating Brick has resulted in the discontinuance of Sil-O-Cel Natural Brick. The outstanding properties of Sil-O-Cel 16L make it the ideal replacement for Sil-O-Cel Natural Brick for back-up use. In addition, the properties of Sil-O-Cel 16L Brick extend its use to exposed service applications.

JM

Johns-Manville *FIRST IN* INSULATION

MATERIALS · ENGINEERING · APPLICATION

For more data on advertised products, use Readers' Service Cards, last page.

An unbeatable pyrometer for any range between -300° and +2800°F.

This simple variable capacitor is important to potentiometer users because it eliminates the conventional, troublesome slidewire altogether; and it gives Dynalog Instruments the continuous *stepless* balancing which assures higher accuracy, closer control.

*Reg. U.S. Pat. Off.

. . . no batteries to stndardize!

TOPS in simplicity . . . unequalled in its combination of accuracy, sensitivity, and speed of response . . . the Dynalog Potentiometer with standard thermocouples gives you unerring temperature measurement for any range up to 2800°F. Featuring *sustained* accuracy of ¼ of 1% of scale, it's an instrument of laboratory precision built to withstand the severest industrial conditions.

Unprecedented freedom from maintenance is the direct result of unique Dynalog design. There's no slidewire, no battery to standardize. There are no gears, belts, or high speed reversing motors. There's nothing to wear and cause dead space.

Single pen recording models provide full scale pen travel in 3 seconds standard, or as fast as 1 second without extra cost. The Multi-Record Dynalog provides color-coded records of up to 6 points at 6 second intervals. Both types give the convenience and low cost of circular charts.

Dynalog Potentiometers are also used for the measurement of pH, oxidation-reduction potential, and for other applications in which the process variable can be converted to a dc millivolt signal. They are available for pneumatic or electric control.

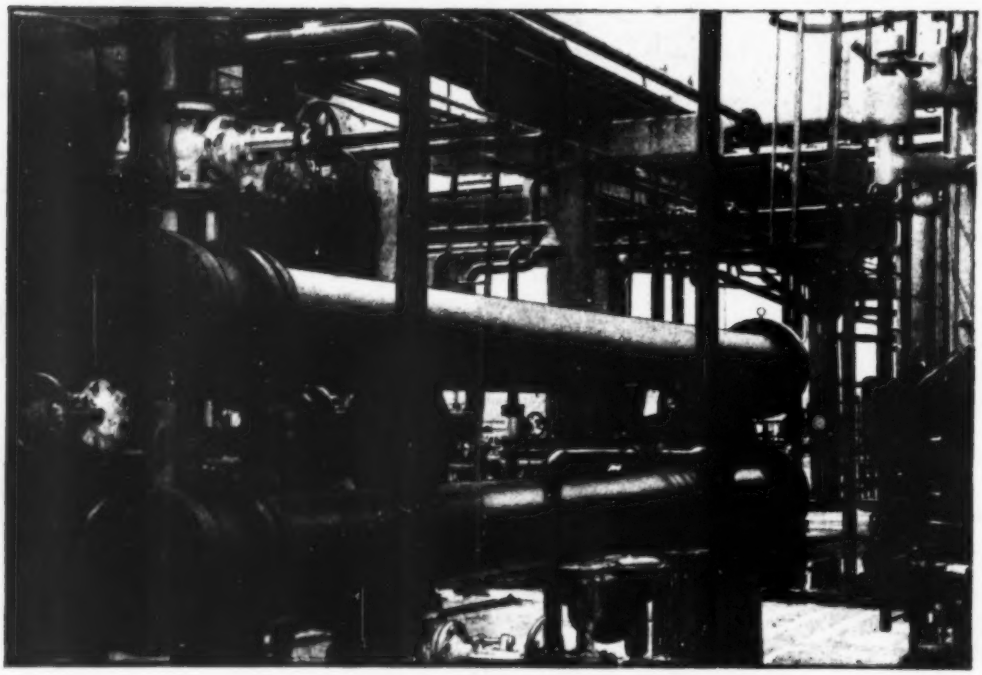
Write for your copy of Bulletin 427-1 which gives the whole story.

THE FOXBORO COMPANY, 746 NEPONSET AVE., FOXBORO, MASS., U.S.A.

FOXBORO POTENTIOMETERS

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

For more data on advertised products, use Readers' Service Cards, last page.



STRIKE IT RICHER

When you find oil, you strike it rich. When you get high processing yields from that oil, you strike it richer. ADSCO helps refineries get the most out of its crude by designing and manufacturing heat exchangers efficiently suited to their process . . .

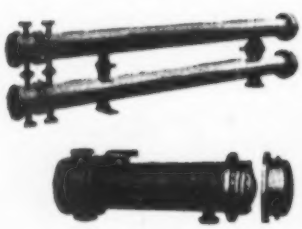
An outstanding example of ADSCO engineering is the installation shown above in a Perth Amboy, N. J., refinery. Here is a liquid-to-liquid heat exchanger consisting of two units arranged in series. The engineers specified only that one liquid was to be cooled from 190° F to 100° F, the other to be heated from 75° F to 165° F. From then on the problem was ADSCO's and ADSCO developed the most economical design in competition with several other heat exchanger manufacturers. Each of the two units has two passes on the tube side and, because of a longitudinal baffle, two passes on the shell side. This permits a counterflow design to get the maximum heat-transfer efficiency. Were it not for the counterflow design, the exchanger would have to be built in three or four units, instead of two, thus increasing the cost . . .

ADSCO cordially invites inquiries.

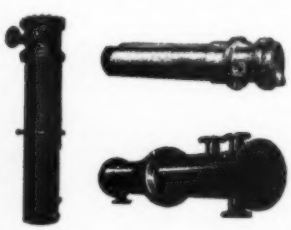
AMERICAN DISTRICT STEAM COMPANY, INC.

GENERAL OFFICES
NORTH TONAWANDA, NEW YORK
PLANTS: NORTH TONAWANDA, N. Y., AND RICHMOND, CALIF.

ADSCO ENGINEERED PRODUCTS FOR THE OIL, GAS, CHEMICAL AND POWER INDUSTRIES



ADSCO
ENGINEERED
PRODUCTS



For more data on advertised products, use Readers' Service Cards, last page.

DRILL HERE!

When the point is pinned within an area and Layne engineers say . . . drill here! . . . it is somewhat more than an educated guess.

Behind those two words may be definite knowledge of the water tables and formations of that particular area gained through experience . . . or perhaps geologists working with the latest equipment possibly including electronic resistivity tests have "pinned the point" with all the accuracy that science will permit.

Accurate preliminary exploration is an all important factor in determining subsequent costs. And it is a job for experts. Second guesses are expensive.

Because Layne's service is complete and with undivided responsibility is one reason why so many of the leading industries and largest municipalities have entrusted major ground water development to this organization. But that service is just as important to the smaller farmer, industry or city.

Whatever a water need may be . . . or wherever it may exist, it is wise to first consult your nearest Layne & Bowler associate company. Information on any phase of water development, maintenance or modernization is yours free for the asking.

Layne Associate Companies Throughout The World

Layne

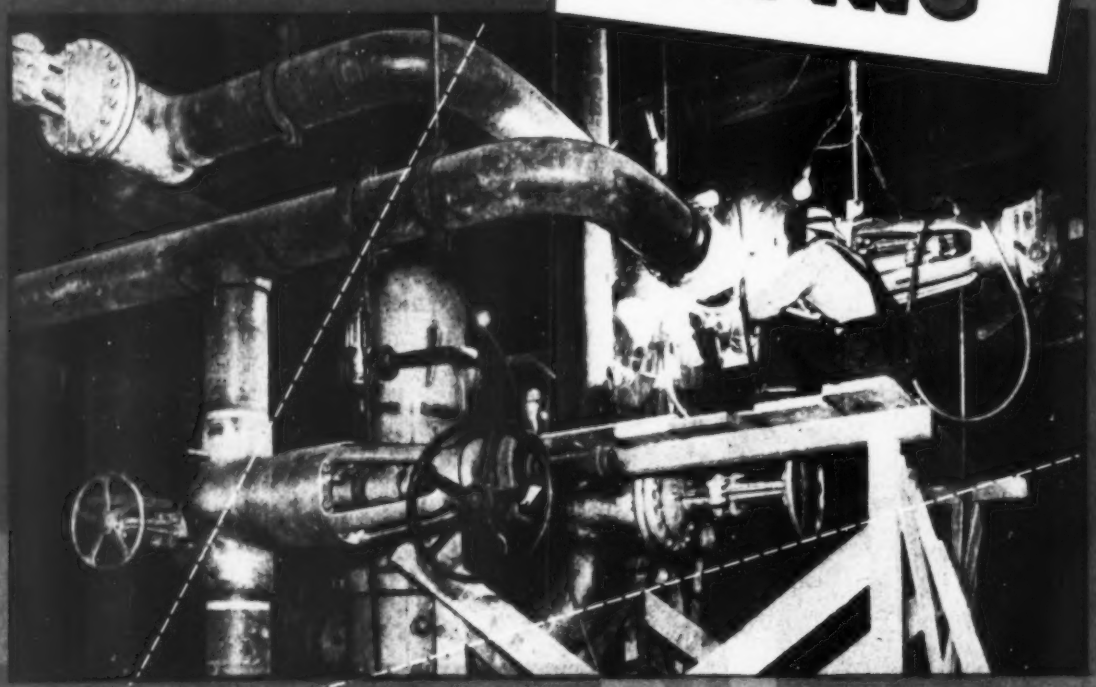
LAYNE & BOWLER, INC.
Memphis 8, Tennessee, U. S. A.

Water Wells • Vertical Turbine Pumps • Water Treatment

THERE IS

MUCH MORE TO

MIDWEST PIPING



THAN MEETS THE EYE

Have you seen carefully qualified Midwest welders erecting the boiler feed piping in a new public utility steam-electric generating station. What you don't see are the many other highly skilled men who contribute to the high quality of Midwest Piping.

First, there are the expert piping engineers who prepare the job for fabrication. They simplify the field work and make sure the difficult operations are done in the shop. And they often make suggestions that improve the design and reduce the cost of the piping.

Then there is the experienced shop organization (working with the most modern equipment) that delivers to the field subassemblies which are accurate in dimension, correct in alignment, thoroughly cleaned, heat treated when necessary, carefully inspected and tested . . . ready for erection at lowest cost. Both the shop and field supervisory personnel have come up through the ranks and know every phase of the operations . . . how to assure the customer the most for his money when he buys Midwest Piping.

MIDWEST PIPING COMPANY, INC.

Main Office, 1450 South Second St., St. Louis 4, Mo.

PLANTS: ST. LOUIS, PASSAIC, LOS ANGELES, and BOSTON

SALES OFFICES: NEW YORK 7—50 CHURCH ST. • BOSTON 27—496 FIRST ST.
LOS ANGELES 33—520 ANDERSON ST. • CHICAGO 3—79 WEST MONROE ST.
TULSA 3—624 WRIGHT BLDG. • BOSTON 3—2210 CAPITOL AVE.

MIDWEST

PIPING FABRICATION and CONSTRUCTION

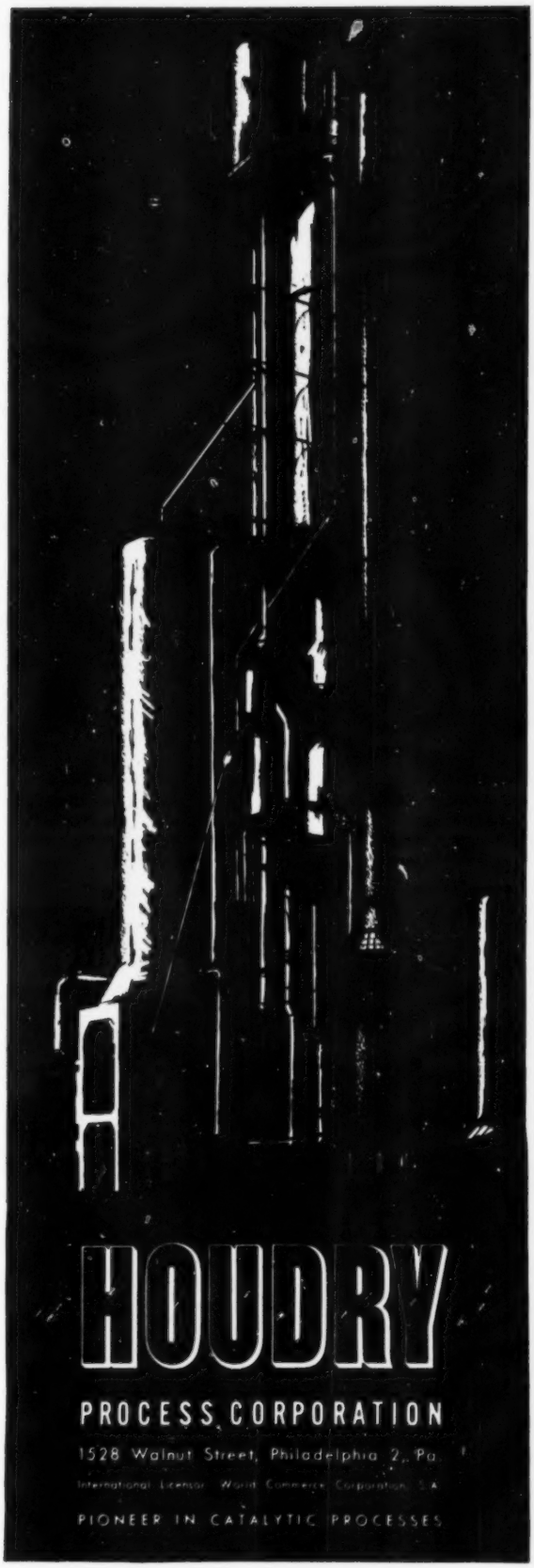
OFFERS YOU MANY BENEFITS

HIGHEST CONVERSION RATES IN REFINING HISTORY!

Extensive commercial operation of Houdriflow Catalytic Cracking units has proved that they achieve conversion rates previously unobtainable. A west Texas Houdriflow charging heavy vacuum gas oils has exceeded 90% conversion of the charge stock—a world's record. Only 3 to 4 percent of the original crude remained higher boiling than the Houdriflow charge stock.

In addition to record-breaking cracking efficiency, Houdriflow units have shown exceptional mechanical reliability. Turnarounds of units which have been on stream over two years have revealed minimum maintenance requirements.

A request on your letterhead will bring you a new brochure describing the Houdriflow process in detail. Flow diagrams and economics are included.

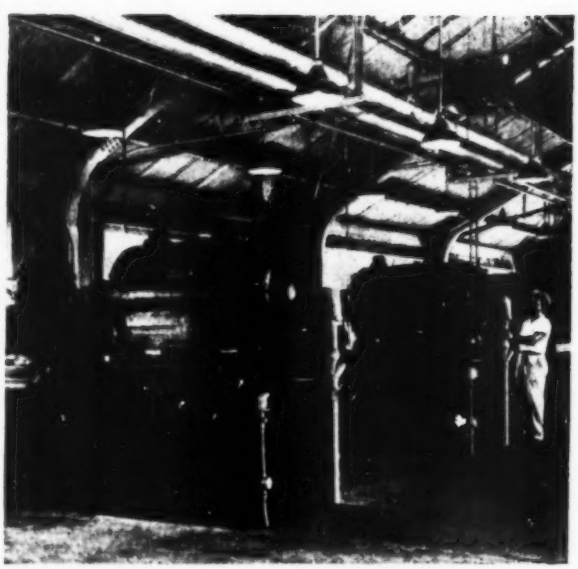


For more data on advertised products, use Readers' Service Cards, last page.

COMPACT, CENTRALIZED CONTROL PANEL handles high-voltage distribution economically for the entire Eagle Point Refinery operation. Incoming power from both plant generators is distributed to transformer banks, G-E limitamp control and switchgear. Interlocks assure safer operation, proper sequence. All enclosures are metal-clad for maximum protection.

G-E equipment helps Eagle Point

SIMPLE, FLEXIBLE DRIVE CONTROL for power station auxiliaries is provided by this G-E Limitamp panel. It protects motors for service pumps, raw water pumps, air supply apparatus.



FOR GREATER CONTINUOUS PROCESSING SAFETY, G-E motors at Eagle Point are totally enclosed, explosion-proof. Here, motors ranging from 200 to 400 hp drive transfer oil pumps.

ROUND-THE-CLOCK PRODUCTION at Eagle Point is aided by dependable G-E outdoor lighting. This modern plant-wide lighting system allows equipment to be moved quickly, safely. Critical operating areas are brightly lighted to step up efficiency of nighttime operating and maintenance work. Result: maximum output, night and day.

boost output 50% over rated capacity

20,000 barrels a day increase at Texaco's Westville, N.J. refinery aided by co-ordinated General Electric equipment

The Texas Company's Eagle Point Refinery in Westville, N. J. recently hit a production high when it boosted its output 50 per cent over rated capacity. General Electric equipment helped in this production increase—approximately 20,000 barrels of crude throughput a day.

Eagle Point is another of this country's top refineries to use co-ordinated G-E equipment and engineering services. G-E engineers, specializing in refinery applications, helped the Texas Company plan the electrical system, which includes provisions for future plant expansion. High-voltage distribution is one of the system's key features power is transmitted to substations at 13,800 volts, reducing losses and improving voltage regulation.

If you are planning to build, expand, or modernize, let a team of G-E engineers help you design an electrical system for top production and flexibility. Contact your nearby G-E Apparatus Sales Office early during the preliminary planning. General Electric Company, Schenectady 5, N. Y. 661-43

Engineered Electrical Systems for Petroleum Refineries

GENERAL ELECTRIC

For more data on advertised products, use Readers' Service Cards, last page.

Pushing a Button

is SAFER EASIER QUICKER

LIMITORQUE®

push button operation

LimiTorque opens and closes any type of valve in a fraction of the time required for hand operation. *It is absolutely dependable and safe,* even when pressures are so *high* that manual operation is almost impossible . . . when valves are exceptionally *hot* . . . or where its location is *hazardous* or *inaccessible.*

Thousands upon thousands of these "time-tried and tested" *Valve Operators* are in continuous use, all over the world.

Of course, *LimiTorque* offers a number of "exclusive advantages" in design and construction, which not only give dependable, safe and speedy performance, but which are your *guarantee* against damage to valve stems, seats, discs, plugs, or gates . . . not to mention possible physical injury to operators.

If you have *valve operating problems,* write us —and a "Philadelphia Engineer" will gladly call.

Thousands are used on Pipe Lines and in Refineries throughout the World.

Philadelphia Gear Works, INC.

ERIE AVE. AND G ST., PHILADELPHIA 34, PA.

NEW YORK • PITTSBURGH • CHICAGO • HOUSTON • LYNCHBURG, VA.

Industrial Gears and Speed Reducers
LimiTorque Valve Controls

ANOTHER CALSTEEL FABRICATION JOB!

1

2

CALSTEEL

ENGINEERED FABRICATION

CUSTOM INSTALLATIONS FOR BEST FOODS, INC., SAN FRANCISCO

Fabricated and erected by CALSTEEL. *Including (1) a battery of Winterizing Cells with Ammonia Coils; (2) 10' 6" diameter 20% Stainless Clad Cooker; as well as 11' 6" diameter 20% Stainless Clad Deodorizing Kettles.*

● The custom-engineered fabrications for this modern plant illustrate again the scope of CALSTEEL services. Whether for the Process, Oil, Gas, Atomic Energy or Power Industries, CALSTEEL fabrication assures precision execution of the most exacting specifications. For *your* fabrication requirements, call on CALSTEEL.

STEEL and ALLOY PLATE
STRUCTURAL • PIPE
for the
Process, Oil, Gas
Atomic Energy and
Power Industries

CALIFORNIA STEEL PRODUCTS COMPANY

DIVISION OF AMERICAN DISTRICT STEAM COMPANY, INC.

GENERAL OFFICES: RICHMOND, CALIFORNIA

PLANTS IN RICHMOND, CALIF. & NORTH TONAWANDA, N. Y.

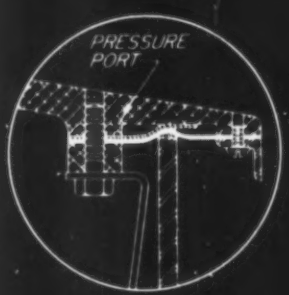
District Offices: San Francisco • New York • Chicago • Philadelphia • Pittsburgh • Cleveland • Detroit • Buffalo

For more data on advertised products, use Readers' Service Cards, last page.

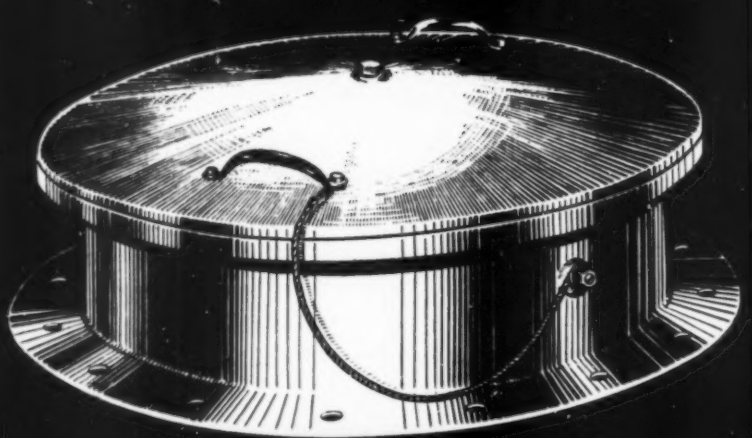
ALL WEATHER
Emergency Vent...

The new Shand & Jurs 20" Emergency Vent is designed for mounting right on a 20" A.P.I. Standard manhole. It incorporates a unique pallet construction which utilizes a pliable, reinforced, synthetic rubber coated Safety Seal Ring which provides the tightest possible seal. This assures minimum vapor loss at tank pressures less than the vent setting.

The Safety Seal Ring design provides a peeling action between the pallet and the seat which overcomes sticking or freezing to a very marked degree. When serious freezing hazards exist, a special Safety Seal Ring of Teflon coated fiberglass may be used. The Safety Seal Ring also resists chemical action of additives which provides longer dependable service. Designated by S&J Fig. ST-5455, this Emergency Vent serves as a quickly removable manhole cover and as an automatically self-sealing Emergency Vent.



Pallet and Seal detail illustrated above. In operation, tank pressure is directed through ports to the chamber back of the safety seal ring and produces a slight ballooning to effect a perfectly tight joint at all pressures below that for which the vent is set to open.



Shand and Jurs Co.

BERKELEY 10, CALIFORNIA

NEW YORK
342 Madison Ave.

HOUSTON
M & M Bldg

TULSA
Thompson Bldg

CHICAGO
10409 S. Western Ave.

LOS ANGELES
714 W. Olympic Blvd.

REPRESENTATIVES
SEATTLE Nathan Supply Company, 3000 Western Avenue
MONTREAL Lytle Engineering Specialties, Ltd., 360 Notre Dame St. W.
TORONTO Lytle Engineering Specialties, Ltd., 85 Richmond St., W.
VANCOUVER P. D. McLaren & Son, Ltd., 3277 Main Street
CARACAS Sinclair Spence, C.A., Edificio Galipan
ENGLAND Whessoe, Ltd., Sales, 25 Victoria St., London, S.W. 1
Whessoe Ltd. Works, Darlington, County Durham

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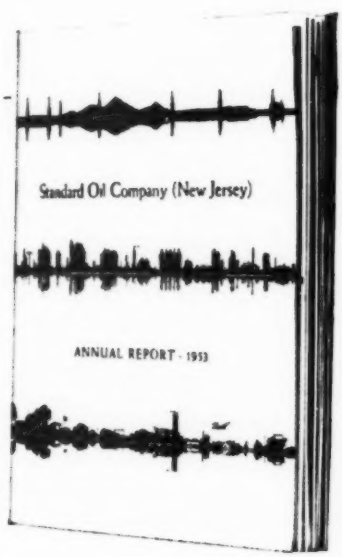
A report that concerns everyone!



THE BUSINESS OF FINDING, refining and bringing to market the world's oil is a big and continuing job—one in which Standard Oil Company (New Jersey), among many others, plays a significant part.

How this job is done affects America in many ways—and is therefore important to every American. Our Annual Report for 1953, recently mailed to the 284,000 shareholders who own this company, tells about our part in this job, and some of its high lights may interest you.

* * *

Today, when many thoughtful people are wondering about the economic future, we're glad to say that things look good to us. As far as we can see from the evidence available, the economy of the free world is stronger now than at any time since World War II.

But more important than hopeful words are positive actions.

Since 1946 Standard Oil Company (New Jersey) and its affiliated companies have spent nearly 4 billion dollars on new facilities to help supply the oil needs of free people... a 4-billion-dollar vote of confidence in the future. This year we intend to invest even more than the 500 million dollars we spent last year.

The result? Continuously increasing reserves of oil in the ground. Modern equipment. More efficient operations. New and better products.

Our customers used more oil in 1953 than ever before, which meant that people lived better, that industry was more active, that the free world's economy prospered.

We took in more money, and paid out more wages and salaries to employees, more taxes to governments, more dividends to shareholders than in any previous year.

Esso research made great strides ...outstanding gasolines and lubricants were among the results of dynamic progress in this field.

* * *

These activities—these investments made to get people the oil they need—are vital factors in our nation's economy, for they directly affect thousands of businesses and individuals. And everybody benefits.

This is a continuing process. It has been our job for 72 years. It will continue to be our job.

IF YOU'D BE INTERESTED in receiving a copy of our 1953 Annual Report, write Standard Oil Company (New Jersey), Room 1626, 30 Rockefeller Plaza, New York 20, N. Y.

STANDARD OIL COMPANY (NEW JERSEY)
and affiliated companies

ESSO

For more data on advertised products, use Readers' Service Cards, last page

Depend on LADISH

To Meet All Your Fittings Needs With an Unsurpassed Range of Sizes and Materials

Ⓛ TO MARK PROGRESS

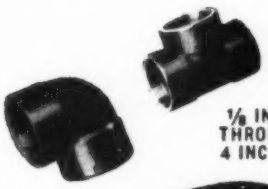
1. BUTT WELDING FITTINGS
2. A.S.A. FORGED FLANGES
3. FORGED SCREWED OR SOCKET WELDING FITTINGS
4. T.E.M.A. HUB & RING FLANGES
5. LONG WELDING NECKS
6. LARGE DIAMETER FLANGES AND RINGS

Available in...

Complete Service . . .

⅛ INCH THROUGH 42 INCHES

½ INCH THROUGH 24 INCHES



⅛ INCH THROUGH 4 INCHES

6 INCHES THROUGH 46 INCHES

½ INCH THROUGH 24 INCHES

UP THROUGH 20 FEET O.D.

CARBON, STAINLESS AND ALLOY STEELS, ALUMINUM, NICKEL AND OTHER FERROUS AND NON-FERROUS METALS

To Meet Your Entire Fittings Needs with a Line Complete In All 6 Major Types

For dependable service that results from an ideal combination of broad line and ample stock . . . specify and buy LADISH . . . the Controlled Quality line that offers a complete range of sizes, types, weights, pressure ratings and materials needed for virtually any piping installation. Your local Ladish distributor's ample stock is backed by complete factory inventories to keep your piping jobs on schedule. So, for *complete service* in fittings . . . specify and buy LADISH.

For your new 304-page Ladish Fittings Catalog, No. 55 contact your Authorized Ladish Distributor, your local Ladish District Office, or write to Ladish Co., Dept. PR, Cudahy, Wis

THE COMPLETE *Controlled Quality* FITTINGS LINE
PRODUCED TO ONE STANDARD OF UNSURPASSED QUALITY

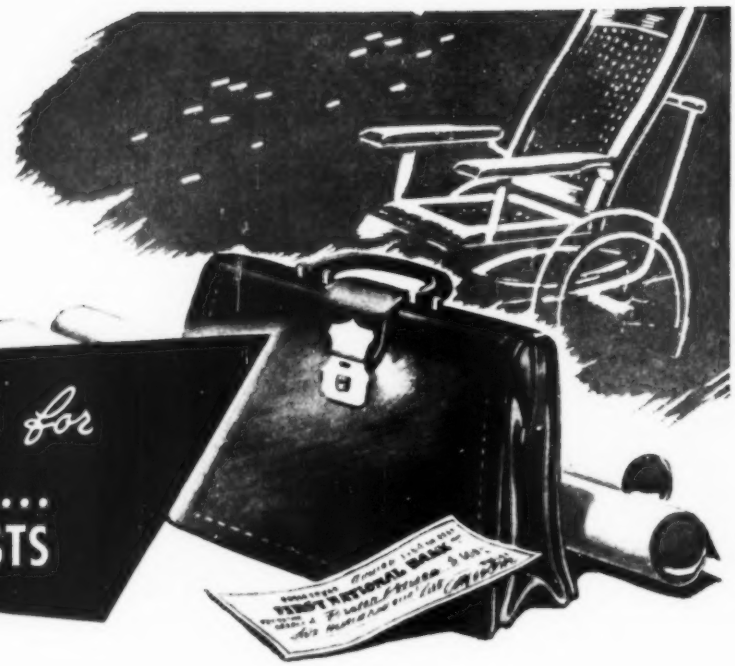
LADISH CO.

CUDAHY, WISCONSIN
MILWAUKEE SUBURB

District Offices: New York • Buffalo • Pittsburgh • Philadelphia • Cleveland • Chicago • St. Paul
St. Louis • Atlanta • Houston • Tulsa • Los Angeles • San Francisco • Havana • Mexico City • Brantford, Can.

CLAIMS AND ENGINEERING SERVICE

Responsible for
REDUCTION in.... INSURANCE COSTS



What
POLICYHOLDERS *Say*

This is one of many testimonial letters received from policyholders of the Texas Employers Insurance Association.

Ask the Texas Employers representative nearest you to show you more of these letters, as proof of what Texas' largest writer of Workmen's Compensation Insurance can do for you.

40TH ANNIVERSARY

WE QUOTE FROM A POLICYHOLDER'S LETTER

"Please accept our thanks for the dividend check in the amount of $2,962.24 which you delivered to me today. This cash dividend, together with guaranteed cost discount deducted previously makes a total savings of 43.6 percent on our workmen's compensation insurance.

"It will be appreciated if you will express our appreciation to your claims and engineering departments for the fine service they have rendered us. The service of your safety engineer together with the promptness in which our claims have been handled are in a big way responsible for this nice reduction in our insurance cost."

Largest Writer of WORKMEN'S COMPENSATION INSURANCE *in Texas*

HOMER R. MITCHELL, *Chairman of the Board* A. F. ALLEN, *President*

Service Offices: ABILENE • AMARILLO • AUSTIN • BEAUMONT • CORPUS CHRISTI • DALLAS • EL PASO FORT WORTH • FREEPORT • GALVESTON • HARLINGEN • HOUSTON • LUBBOCK • MIDLAND ODESSA • PORT ARTHUR • SAN ANGELO • SAN ANTONIO • SHERMAN • TYLER • WACO • WICHITA FALLS

TEXAS EMPLOYERS INSURANCE ASSOCIATION
HOME OFFICE - DALLAS, TEXAS

LARGEST AVAILABLE CHOICE OF STANDARD STYLES

FURNISHED WITHOUT DIE COST

"Shop PSC First" may remind you of the slogan of one of your local department stores. Actually there is a real resemblance between the two institutions in one characteristic:-- Wide Selection. The Pressed Steel Co. offers you the largest choice of standard styles of bubble caps and risers available: 300 of the most commonly specified styles. As a result PSC not only makes prompt delivery, but we also save you the cost of dies. Caps to meet special needs will be promptly designed.

PSC bubble caps and risers are fabricated from the complete list of alloys, and for any method of tray assembly. Let us show you why the majority of the industry's fractionating facilities today use PSC bubble caps. Send blue prints or write as to your needs. Also welded alloy tubing and assemblies.

Send for
PSC BUBBLE CAP CAT'G 54

We believe it is the largest compilation of engineering data on bubble caps and risers in printed form. Also contains drawings for use in determining methods of tray assembly.

The PRESSED STEEL Co. PSC

THE PRESSED STEEL COMPANY
of WILKES-BARRE, PENNSYLVANIA

Industrial Equipment of Heat and Corrosion Resistant WEIGHT-SAVING *Sheet Alloys*

☆ ☆ ☆ OFFICES IN PRINCIPAL CITIES ☆ ☆ ☆

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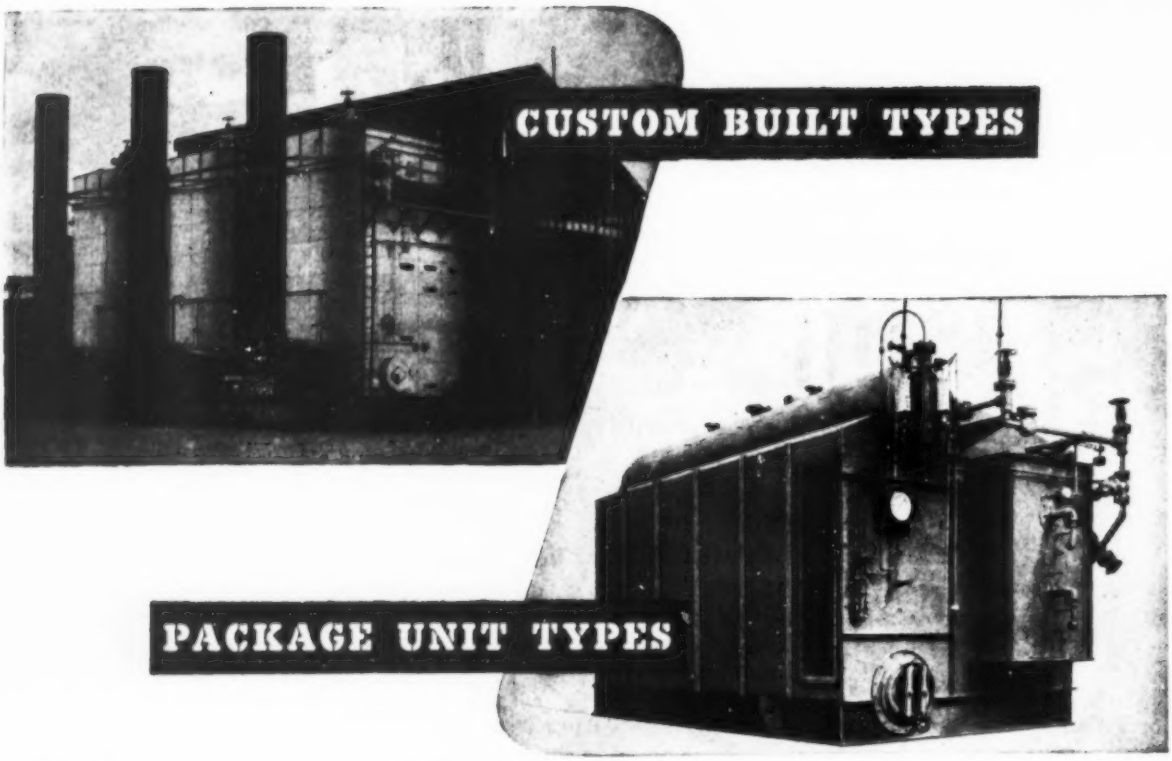


Stop 'n Shop at Vogt

for modern Steam Generators

Types and Sizes for Every Power, Processing and Heating Requirement

Steam costs too high? Then it's high time to replace outmoded boilers with modern Vogt steam generators of the type and size to exactly fit in with specific operating conditions.

Vogt steam generators are designed to give maximum rating in minimum space, with high efficiency and low maintenance expense. They are available in bent tube types and straight tube, forged steel sectional header types for solid, liquid or gaseous fuels burned singly or in combination.

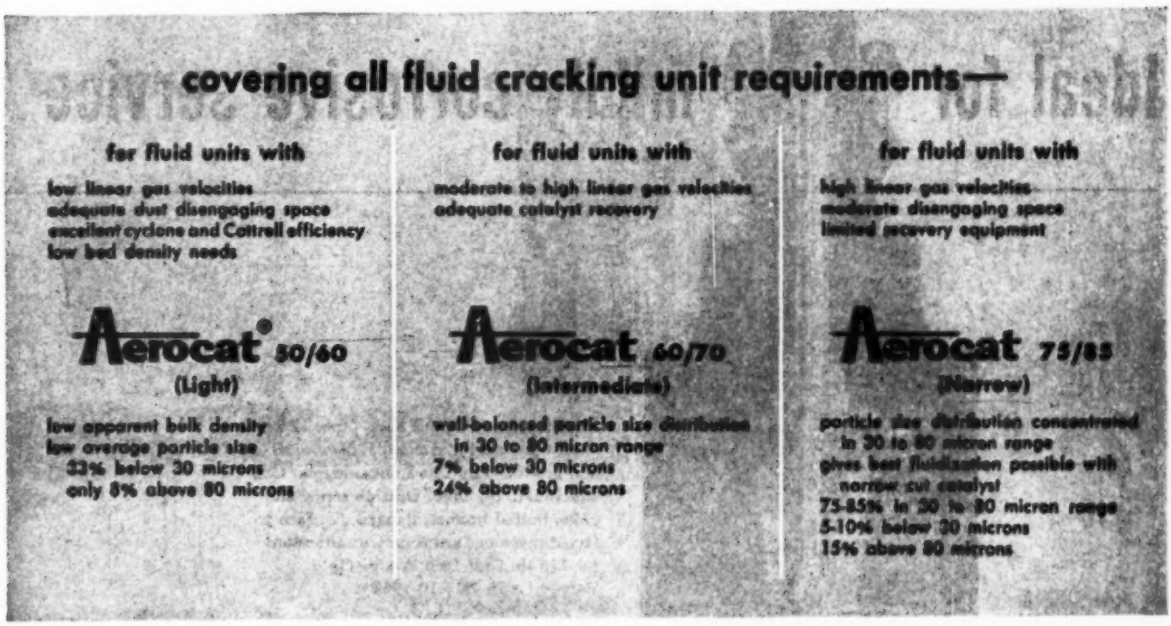
Package units range from 10,000 to 30,000 pounds capacity and custom built units are obtainable in the larger capacities. Many installations in successful operation are proof of Vogt's ability to give effective help in the solution of steam generating problems. Bulletins may be had upon request.

HENRY VOGT MACHINE CO.

For more data on advertised products, use Readers' Service Cards, last page.

Now, for a new high in catalyst utilization!

three new grades of Synthetic Fluid Cracking Catalyst



Better catalyst usage, higher fluid cracking efficiency

Based on existing fluid unit needs

To provide refiners a better selection of fluid cracking catalyst grades, we first surveyed the industry to pin-point the type of fluid units operating, and their cracking catalyst requirements.

This study revealed certain basic types of operation. Accordingly, the three new grades of AEROCAT MS catalyst were designed to give optimum catalyst usage under any particular set of conditions.

Offers you better selection for higher cracking efficiency

These new grades of AEROCAT cover the entire range of fluid catalyst requirements. The new grades, representing the widest range available anywhere, will help you select the catalyst best suited to *your* fluid catalytic cracking operation.

You will certainly want to consider these grades in connection with your unit requirements. A data sheet will be mailed on request, or you may call on one of our Technical Representatives.

Aerocat® MS Synthetic Fluid Cracking Catalyst

AMERICAN *Cyanamid* COMPANY
REFINERY CHEMICALS DEPARTMENT
30 Rockefeller Plaza, New York 20, N. Y.

In Canada: North American Cyanamid Limited, Toronto and Montreal

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Ideal for mildly corrosive service

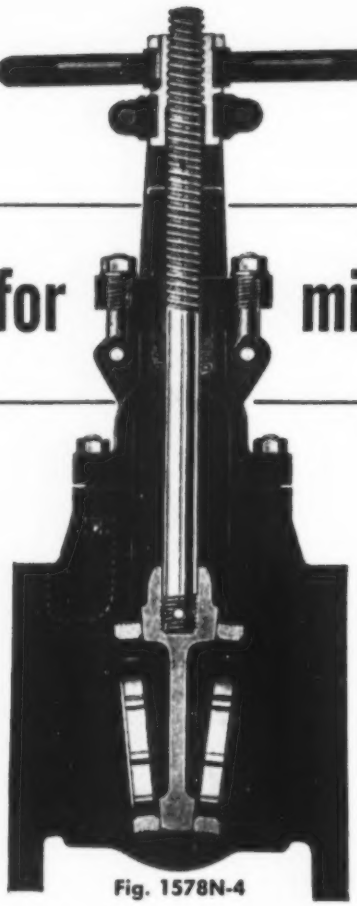


Fig. 1578N-4

3% Nickel Iron Gate Valve, Class 125 lb. . . . for process industries . . . developed and produced by The Lunkenheimer Co., Cincinnati 14, Ohio. Outside screw and yoke, bolted bonnet, flanged . . . face to face dimensions are American Standard for 125 lb. Cast Iron Wedge Gate Valves (ASA B16.10-1939).

LUNKENHEIMER develops new 125 lb. nickel-iron valve for process industries...

Mildly corrosive valve service poses a particularly tough problem in the process industries. To get *maximum* corrosion resistance, you have to pay for more than you need—high-alloy valves are expensive. And yet, ordinary cast iron often won't do the job.

An economical answer to many of these problems has been developed by Lunkenheimer with this new line of Nickel-Iron Gate Valves. Bodies and bonnets are 3% Nickel-Iron, for better corrosion resistance than ordinary cast iron, and trim is offered in choice of 18-8 (Type 316) Stainless Steel or Monel®, for maximum resistance at the point of most severe service. This combination is cutting valve costs in the petroleum field, pulp and paper, wood treating, and scores of other process industries.

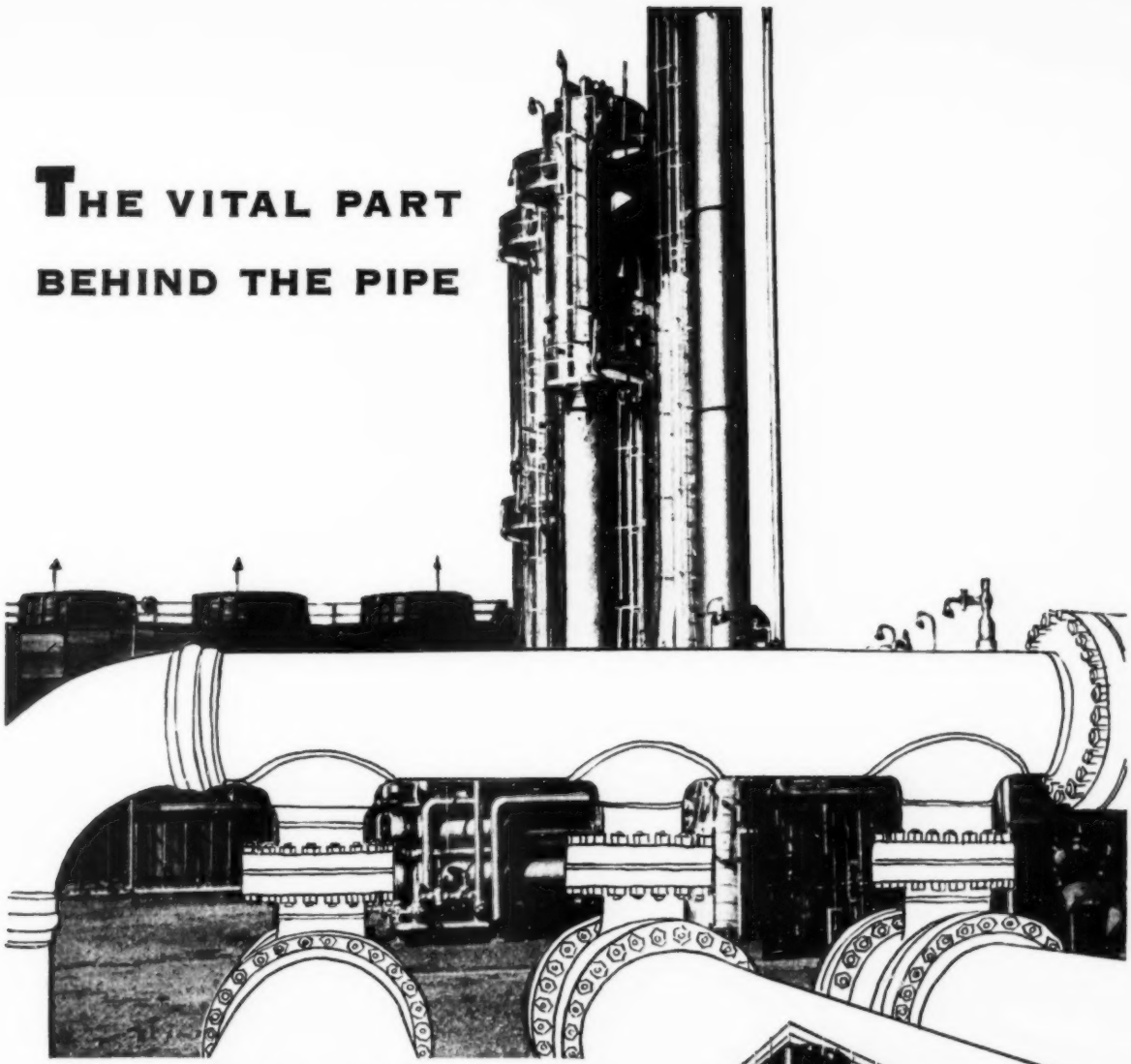
This development is but one more instance that shows how nickel alloys can be used to provide significant advantages, whatever the equipment.

Many standard nickel alloyed compositions are available, making it easy to select one with extra qualities for almost any specific use. Whatever your industry, if you have a metal problem, send us details for our suggestions. Write today.

INCO

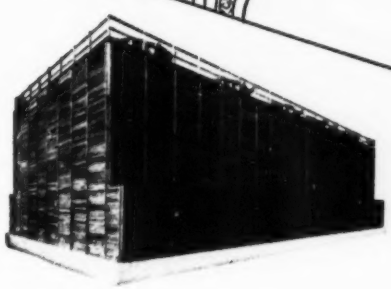
THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N. Y.

THE VITAL PART BEHIND THE PIPE



Look over the top of the pipe running across the picture. Right next to the fractionating columns, you'll see three fan throats of a multi-celled Pritchard cooling tower. Without the efficient functioning of that tower to cool process water, this modern refinery could not operate.

When you are choosing such a vital unit of your installation, remember that you can fully rely on Pritchard's proved design, engineering and construction abilities to provide the cooling tower that *best* meets your requirements.



Industry's Partner for Progress

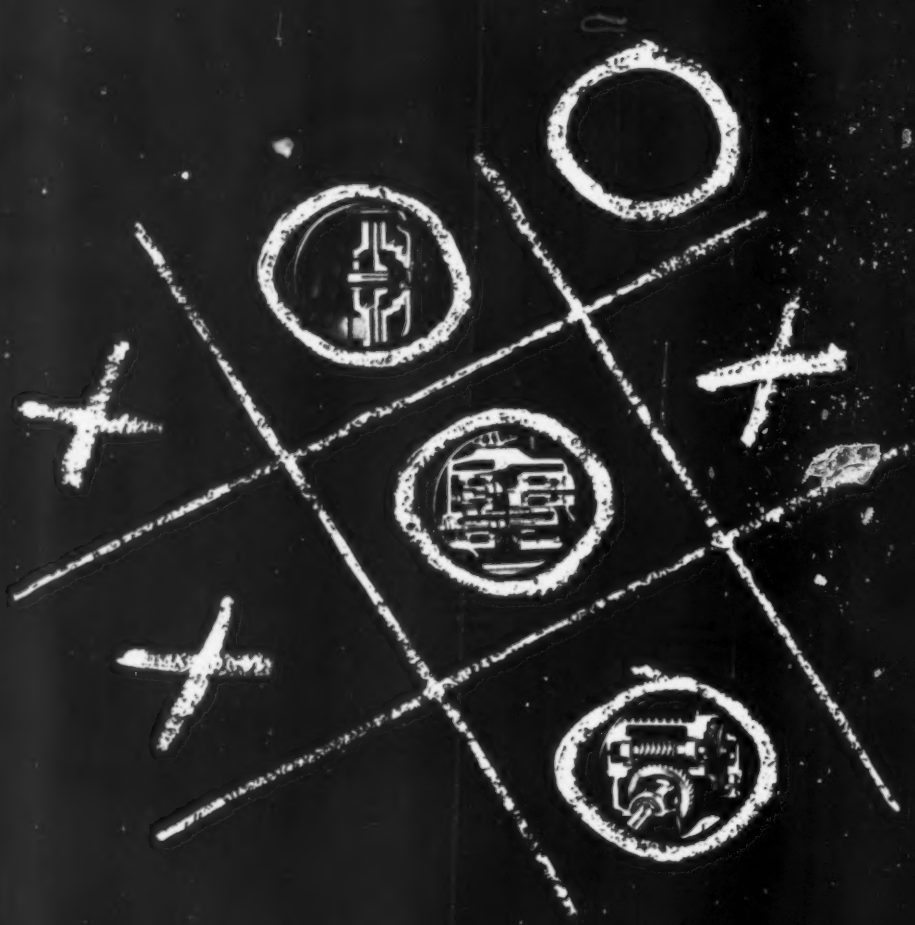
COOLING TOWERS
SPECIALIZED HEAT EXCHANGERS
GAS & AIR TREATING EQUIPMENT

J.F. Pritchard Co.
OF CALIFORNIA
A DIVISION OF J. F. PRITCHARD & CO

Dept. 367 210 West 10th Street, Kansas City 5, Mo.

Representatives in Principal Cities from Coast to Coast

For more data on advertised products, use Readers' Service Cards, last page.



No child's play, this business of properly applying electric motor drives. But you'll find it much easier if you can line up exactly the features you need in one compact, integrally built power unit.

And nowhere will you find a wider selection of sizes and types of electric motors, gearmotors, variable speed drives, fluid-drives, electric brakes, etc., than Master has to offer . . . and they're all designed so they easily combine into a power drive that's just right for each job.

Use Master power drives to increase the salability of your motor-driven products . . . improve the economy and productivity of your plant equipment.

THE MASTER ELECTRIC COMPANY

DAYTON 1, OHIO

FROM THE HORN OF PLENTY AT BONNEY FORGE

WELDOLETS
and
THREDOLETS
for Stainless
and
Alloy Piping

STAINLESS
F 304 304 ELC F 316 F 347

CHROME MOLY
A 182 F 12 F 11 F 22 F 5

MONEL

WROUGHT IRON

ALUMINUM

AND OTHER ALLOYS

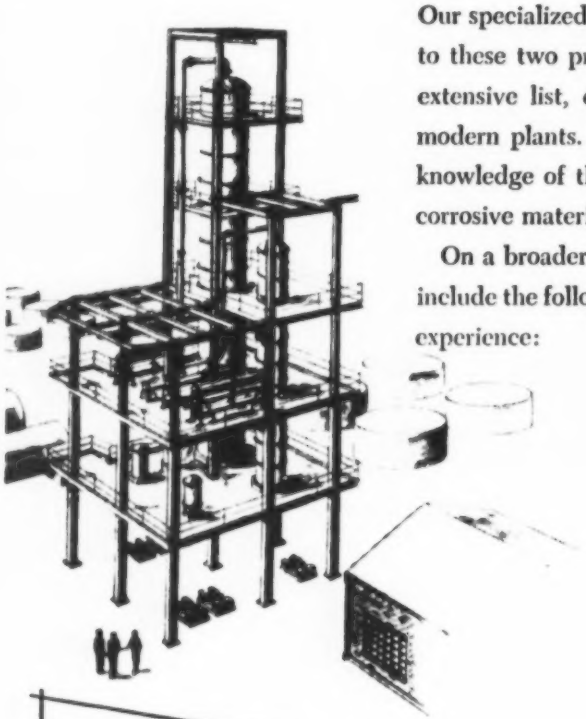
When constructing with alloy, you're investing *real money*. Assure performance-proved fittings and save dollars by specifying and using Weldolets and Thredolets for 90° branch joints—large and small, full size and reducing.

Distributors in Principal Cities

WELDING FITTINGS DIVISION
BONNEY FORGE & TOOL WORKS
ENG. DEPT., 721 MEADOW STREET
ALLENTOWN, PENNSYLVANIA

2 Current Projects of Interest

- **Catalytic Polymerization**
- **Secondary Butyl Alcohol Synthesis**



Our specialized experience with the chemical problems peculiar to these two projects, which have been selected from a rather extensive list, qualified us to design and construct these two modern plants. In particular, these processes require a special knowledge of the chemical reactions involved, the handling of corrosive materials and product separation.

On a broader scale our engineering and construction services include the following, in each of which we have had considerable experience:

Organic Chemical Synthesis

Inorganic Chemical Processing

Catalytic Operations

Solvent Purification

Separation and Refining of Organic Chemical Mixtures by conventional, azeotropic and extractive distillation, liquid-liquid extraction, crystallization

Petroleum Processing:
Topping and Vacuum Distillation
Lube Oil Units

Coal Tar Distillation

Gas and Vapor Recovery

Pharmaceuticals

If you have any plans involving a new plant or unit, expansion or modernization, we shall be glad to discuss them and outline our methods of procedure.

Engineering

Design and Construction of Process Plants

●

Design and Construction of Process Units

●

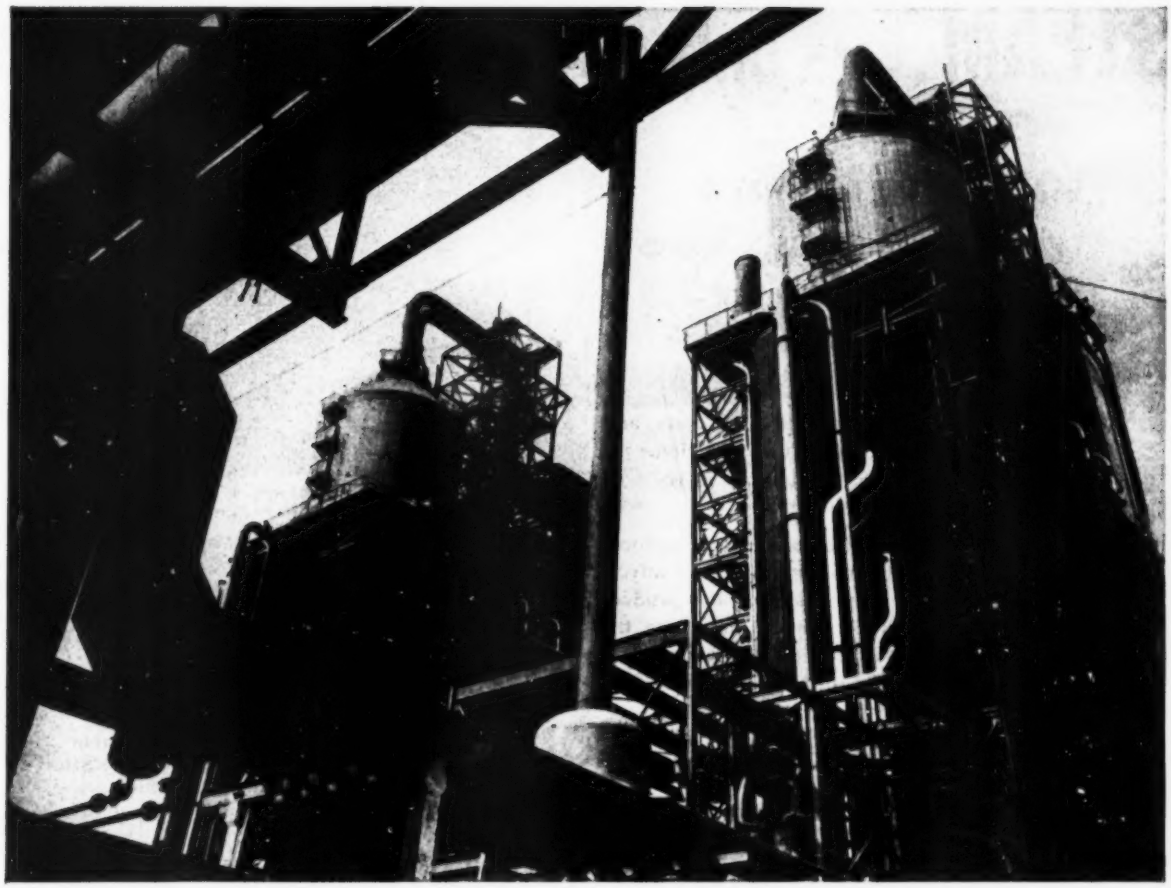
Process Evaluations

●

Economic Studies

BADGER MANUFACTURING COMPANY

230 BENT STREET, CAMBRIDGE 41, MASS. • 60 EAST 42nd STREET, NEW YORK 17, N. Y.



ENDURO'S BONUS BENEFITS SAFEGUARD REFINERY INVESTMENTS

Equipment that resists the effects of heat and pressure . . . that discourages coking and fouling . . . that stays on stream . . . is equipment that pays its way and safeguards your investment.

Such qualities are built into equipment made of Republic ENDURO Stainless and Heat-Resisting Steel.

You may buy ENDURO equipment specifically for heat-resistance. Or for its high strength-to-weight ratio. Or, for ease of cleaning during turn-arounds. Automatically, you get all of its other advantages. Because, of all commercial metals, only stainless steel offers a *combination* of so many high physical and chemical advantages.

ENDURO's bonus benefits include its smooth, wear-resistant surfaces that discourage coke build-up. Abrasion-resistance. Ease and speed of cleaning. High strength without excess bulk . . . at both ends of the thermometer. Ease of fabrication. Ready availability.

Eventually, you'll want to apply all of ENDURO qualities. Now is the time to start planning. Republic will help. Just write:

REPUBLIC STEEL CORPORATION
Alloy Steel Division • Massillon, Ohio
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, New York

REPUBLIC STEEL

REPUBLIC ENDURO STAINLESS STEEL

Other Republic Products include Carbon and Alloy Steels — Bolts, Studs, Nuts and Rivets — Steel and Plastic Pipe — Heat Exchanger Tubes

For more data on advertised products, use Readers' Service Cards, last page.

STEAM...is only as good as you use it!

Use steam the right way to reduce production costs, improve product quality and output—

When production slow-downs, high costs, and poor product quality occur, don't always blame the process equipment—often the fault is in *the way steam is used.*

For example, waterlogging caused by improper trapping or poor steam circulation, seriously affects heat transfer, reduces output, and creates production bottlenecks. Improper air venting does the same. Poor temperature control can lower product quality, cause rejects and further raise production costs.

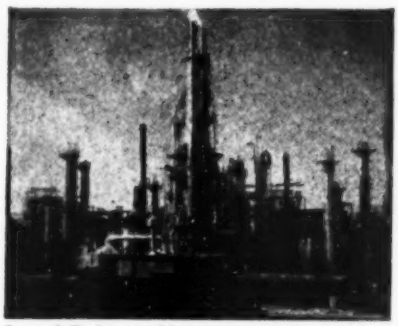
If your plant is suffering from any of these production handicaps, Sarco can help you.

Plant after plant has benefited from Sarco's experience in the process industries. The complete line of Sarco steam traps and temperature controls enables Sarco engineers to offer impartial, expert recommendations on how to make steam work best in your plant.

Why not call on Sarco for engineering recommendations next time you need help. For case histories describing how other plants in your field solved similar problems, write today to Sarco Company, Inc., Empire State Building, New York 1, N.Y.

SARCO

improves product quality and output



Laurel Refinery, Montana, uses Sarco traps and heating specialties throughout its new $4½ million addition.

25° below zero but the tracer lines never freeze

It wasn't that way in 1950. At that time the Laurel Refinery in Montana suffered frequent production delays due to frozen tracer lines. The cause: faulty traps which failed in a *closed position.*

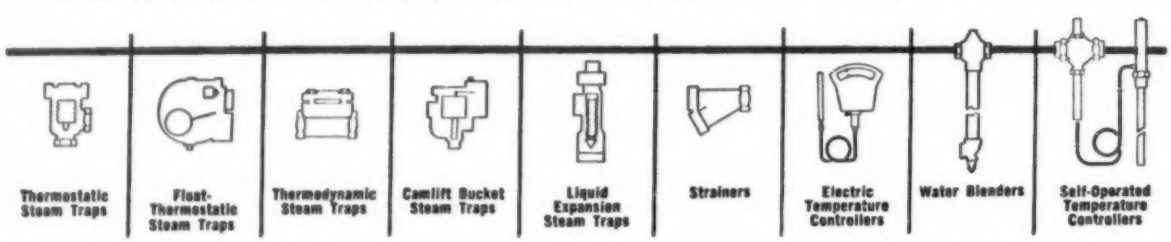
Mr. C. A. Cromwell, plant superintendent, replaced these with Sarco Liquid Expansion Traps. Should the element be damaged in these traps, they will remain in the *open position*—thus freezing is impossible with proper trap installation.

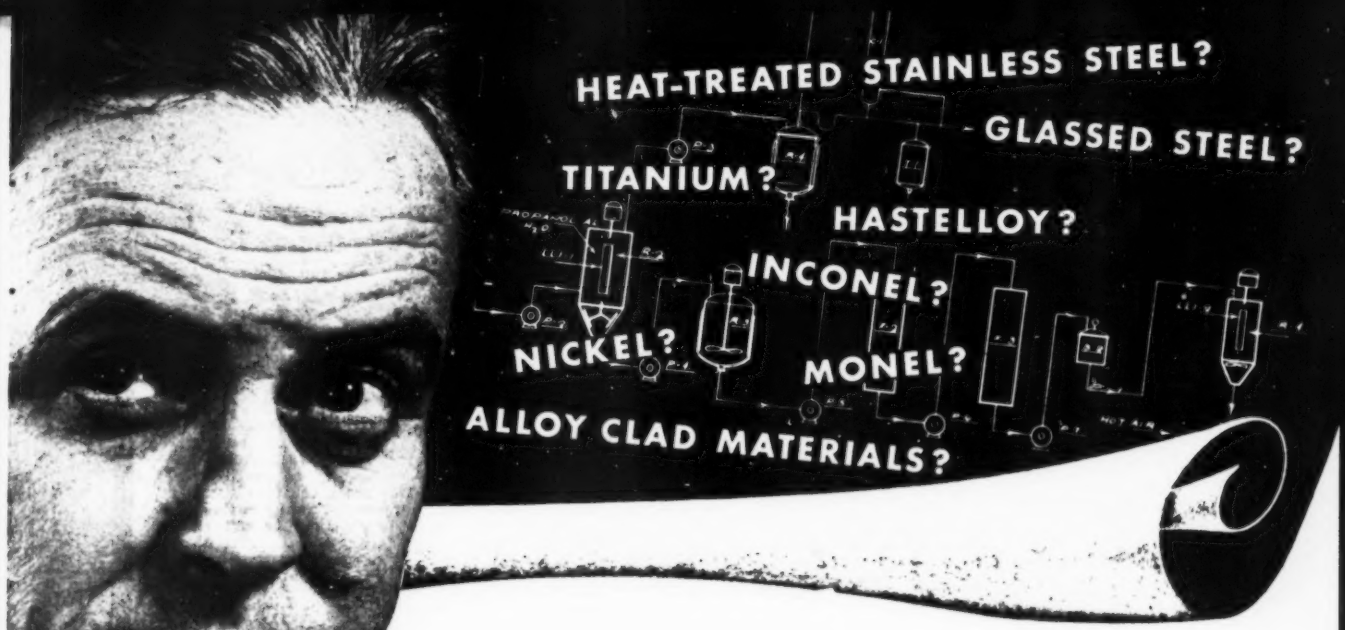
Mr. Cromwell advises no further production delays occurred due to frozen tracer lines. This trap performance resulted in the specification and use of Sarco heating specialties throughout the refinery's new $4½ million addition.

Sarco Liquid Expansion Thermostatic Trap

Discharges condensate at pre-set temperatures below 212° F. Withstands waterhammer, pressure pulsations and superheat. Freeze-proof. *Write for Bulletin 260.*

STEAM TRAPS • TEMPERATURE CONTROLLERS • STRAINERS





What does Pfaudler corrosioneering offer you?

Improper selection of materials of construction can cause all kinds of trouble . . . rapid corrosion of equipment, poor yields, product contamination, to mention a few. Result? Red figures!

No one wants to be involved in such an error. But mistakes can easily occur – through haste, misguided attempts at economy, or plain lack of experience. And with so many materials available, selection of the best is a more complex problem than ever before.

Experts in corrosioneering, Pfaudler can help you avoid mistakes. In designing and fabricating process equipment for nearly 70 years, Pfaudler has accumulated a wealth of experience in handling the widest range of materials. This experience can help you select equipment made of material best suited to *your* purpose.

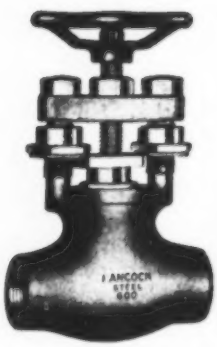
Perhaps the answer to your need is heat-treated, unstabilized 300 series stainless steel which is corrosion resistant and less costly than the stabilized types. Or maybe you need Pfaudler glassed steel, various types of which are resistant to both acids and alkaline solutions up to pH 12 and 212° F. But whether it is these or alloys of nickel, titanium or other metals, you can depend on Pfaudler for the right answer.

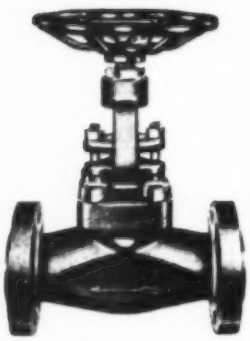
Try us on your requirements – whether they involve a complete process assembly or individual units. Bulletin 902-R-6 explains how you can use Pfaudler services and facilities to best advantage in minimizing corrosion costs as well as getting better yields. Send for it today.

FREE—Buyers' Guide to Pfaudler Equipment and Services . . . a useful reference for process and maintenance engineers. Send for it today.

THE PFAUDLER CO. **ROCHESTER 3, N. Y.**

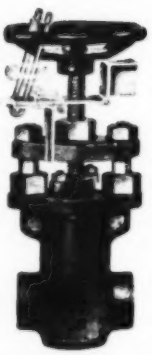
for the economy of quality...





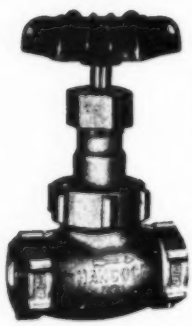
600# through 2500# Hi-Pressure Drop Valves. For continuous blowdown service. Combine orifice, shut-off and index in a single unit. **No Bonnet Joint Design. Sizes:** ¾", 1" and 1½". **Orifice Sizes:** ⅛" minimum; 1" maximum. **Connections:** Screwed or Socket Weld Ends.

600# Steel Valves. Dependable, trouble-free in the severest services. **Sizes: No Bonnet Joint Design** (left) — ¼" through 2". **Bolted Bonnet Design** (right) — 1¼" through 2". **Types:** Globe and Angle. **Connections:** Screwed, Socket Weld and Flanged Ends. **Service Ratings:** For all pressures up to 850 psi at 750° F. — O.W.G. 2000#, 100° F.



Water Column Shut-Off Steel Gate Valves. Combine a simple, positive locking and signaling device. Red flag indicates at a glance whether valve is open or closed. **Sizes:** ¼" through 2". **Connections:** Screwed and Socket Weld Ends. **Service Ratings:** For all pressures up to 800 psi at 775° F.—O.W.G. 2000# 100° F.

"Flocontrol" Valves. 3-in-1 design combines variable orifice, shut-off and index. BRONZE: **Types:** Globe and Angle. **Sizes:** ¼" through 2". **Connections:** Screwed Ends. Available in 150# and 300# series. STEEL: **Types:** Globe and Angle. **Bolted Bonnet and No Bonnet Joint Designs. Sizes:** ¼" through 4". **Connections:** Screwed, Socket Weld and Flanged Ends. Available with 150#, 300# and 600# series flanges.



Bronze Valves. Extra tough for leak-proof service. 125% to 230% stronger diaphragm than ordinary bronze valves. **Types:** Globe and Angle. **Sizes:** ¼" through 2". **Connections:** Screwed Ends. Available in 150#, 200# and 300# W.S.P. ratings, 550° F.

HANCOCK VALVES

YOUR INDUSTRIAL SUPPLY DISTRIBUTOR is as close as your telephone. Take advantage of his knowledge and experience in selecting the right Hancock Valve for each service requirement. You can depend on him for prompt deliveries from local stocks.

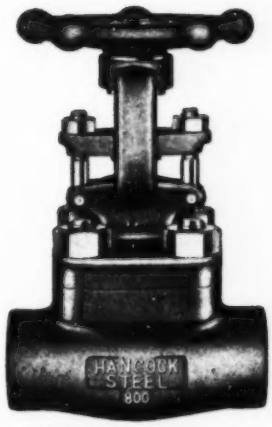
specify HANCOCK VALVES

To get the most value from your valve investment, you must have the assurance of efficient, trouble-free performance.

Hancock Valves give you *economy of quality* that makes them your best buy in terms of long, reliable service. They have advanced construction and operational advantages found in no other valves—features backed by more than 75 years of pioneering new designs, new materials and new manufacturing techniques in anticipation of changing needs.

Rugged, precision-built Hancock Valves are noted for dependable tightness month after month under the most adverse conditions of use. They do a job and stay on the job—withstand the deteriorating effects of wire drawing, galling, steam cutting, erosion and corrosion far longer because they are functionally designed and made from carefully selected materials of the highest quality. Standardization of parts in all sizes of each type of valve provides the interchangeability factor so essential to simplified inventory and low-cost maintenance.

The operational perfection and extra service life engineered into all Hancock Valves are yours at the cost of ordinary valves. Whether you are adding new capacity to present facilities, planning a new plant or a revalve project, learn all the money-saving reasons why Hancock Valves belong in your specifications. Complete information is yours on request.



800# Steel Gate Valve,
Bolted Bonnet Design.

800# Steel Gate Valve,
No Bonnet Joint Design.

800# Steel Gate Valves. More than meet the requirements of process piping systems. **Bolted Bonnet Design. Sizes:** ¼" through 2". Type 950 illustrated at upper right offers these alternate trims: (a) Cobalt-Chromium Tungsten Alloy, Hard Facing—"420 Brinell"; (b) 18-8% Stainless or 20% Nickel, 8% Chrome; (c) Monel; (d) Hastelloy. **Connections: Flanged Ends** – for all pressures up to 800 psi at 775° F.—O.W.G. 1440 psi, 100° F. Screwed and Socket Weld Ends—for all pressures up to 800 psi at 775° F. – O.W.G. 2000 psi, 100° F. **No Bonnet Joint Design. Sizes:** ¼" through 2". **Connections:** Screwed and Socket Weld Ends – for all pressures up to 800 psi at 775° F. – O.W.G. 2000 psi, 100° F.

When Hancocks go in, valve costs go down.

1877 HANCOCK U.S.A.

A PRODUCT OF MANNING, MAXWELL & MOORE, INC.

WATERTOWN 72, MASSACHUSETTS

MAKERS OF 'HANCOCK' VALVES, 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN' AND 'AMERICAN-MICROSEN' INDUSTRIAL INSTRUMENTS, AIRCRAFT PRODUCTS. BUILDERS OF "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.

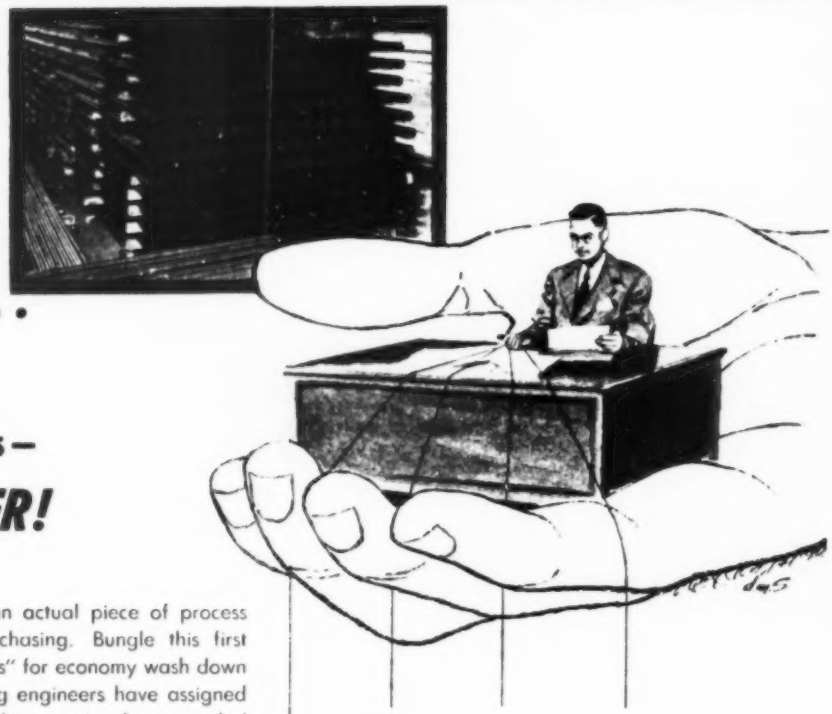
"THE BRAND OF PROGRESS"

By Heat Exchanger Specialists

▲ SYNOPSIS OF AD NO. 4: To provide the company's customers with a complete service in the design and construction of heat transfer equipment, Western Supply Company offers an experienced staff of thermal and mechanical engineers. This group works with the client's own engineering department to speed delivery and provide for maximum economy in labor and materials. A complete heat exchanger engineering service . . . at no additional cost to the customer.

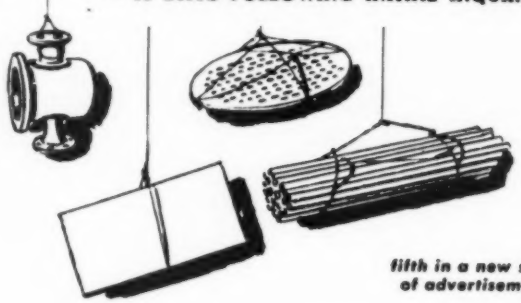
WESTERN'S *Selective* PURCHASING . . .

Builds better Heat Exchangers — FASTER!



Changing a set of blueprints to an actual piece of process equipment always starts with purchasing. Bungle this first step and carefully laid "paper plans" for economy wash down the drain. Once the Western rating engineers have assigned a work order number and the drafting section has compiled the preliminary bill of materials, experienced material clerks go to work carefully checking the list against Western's warehouse stocks. In the Tulsa warehouse (see photo above) large inventories of plate stock, tube-sheets, channels and channel covers, steel and Admiralty tubes are maintained. At Western's **purchasing** department SERVICE calls the play. Special materials have, on occasion, been ordered **in advance** of the client's own equipment purchase order . . . a risk taken by Western so that equipment could be moved quickly through fabricating when the green light was given. Close personal contact is maintained with local and out-of-state supply sources . . . a working arrangement that brings special materials to the modern Western heat exchanger plant via every possible means of transportation.

The process engineers at a large chemical plant recently discovered the beginnings of deterioration in Hexamine solution due to overheating. On Feb. 10th the company called Western . . . by Feb. 12th a 16", 10' fixed tube sheet exchanger had been designed . . . by Feb. 13th shell and tube side stainless steel parts had been located in the warehouse of a Tulsa metal company . . . EXCHANGER SHIPPED BY SPECIAL TRUCK FEBRUARY 25th — 15 DAYS FOLLOWING INITIAL INQUIRY.



WESTERN HEAT EXCHANGERS

WESTERN SUPPLY CO.

P. O. BOX 1888 • TULSA, OKLAHOMA

fifth in a new series of advertisements

ON THE JOB
DAY AND NIGHT-
Low-Cost, Purchased
Electric Power
Purchased Electric Power is the Petroleum Industry's biggest bargain; its cleanest and most efficient servant (notice spotless control room). In every phase of production — from well to refinery — PEP* proves its superiority, dependability and its economy.
*Purchased Electric Power
PRODUCE MORE IN '54 WITH PURCHASED ELECTRIC POWER!
CALL YOUR NEAREST ELECTRIC SERVICE COMPANY for more facts, or address your request to P. O. Box 2771, Dallas, Texas
etroleum lectric ower association
ORGANIZED in the interest of greater service to the petroleum industry

For more data on advertised products, use Readers' Service Cards, last page.

H-1515

U. S. Amazon

MOST AMAZING development in the history of oil discharge hose!

There is no other hose on the market that can match H-1515's contribution to oil transportation.

HERE ARE THE FACTS:

1. Weighs 2/3 less than conventional hose.
2. End fittings weigh 50% less.
3. Used by every major oil company. It has been tried and proven by up to 3 years' service.
4. More than 800 lengths of U. S. Amazon H-1515 now in service.
5. Its light weight eliminates accidents that occur with the handling of heavy hose.
6. Requires less manpower or mechanical handling devices to make connections for loading or unloading.
7. Instantly springs back to shape if crushed or folded.
8. It handles 200 pounds working pressure.
9. Dock workers are outspoken in praise of its lightness and ease of handling.
10. It is indispensable for hard-to-reach bunkering headers. Connections are made without the use of a hoist.
11. No further proof or trial is required to establish its superiority.
12. Easily transported—can be coiled or folded on truck or other vehicle for moving between locations.

More than 800 lengths of U. S. Amazon® H-1515 Oil Discharge Hose have been put into active service from coast to coast in the short space of 3 years—the superiority of this great hose has been proven and accepted beyond question. U. S. Amazon H-1515 is made only by United States Rubber Company and sold through any one of the 27 "U.S." District Sales Offices. Further information is obtainable by writing the address below.

"U.S." Research perfects it.
"U.S." Production builds it.
U.S. Industry depends on it.

US RUBBER

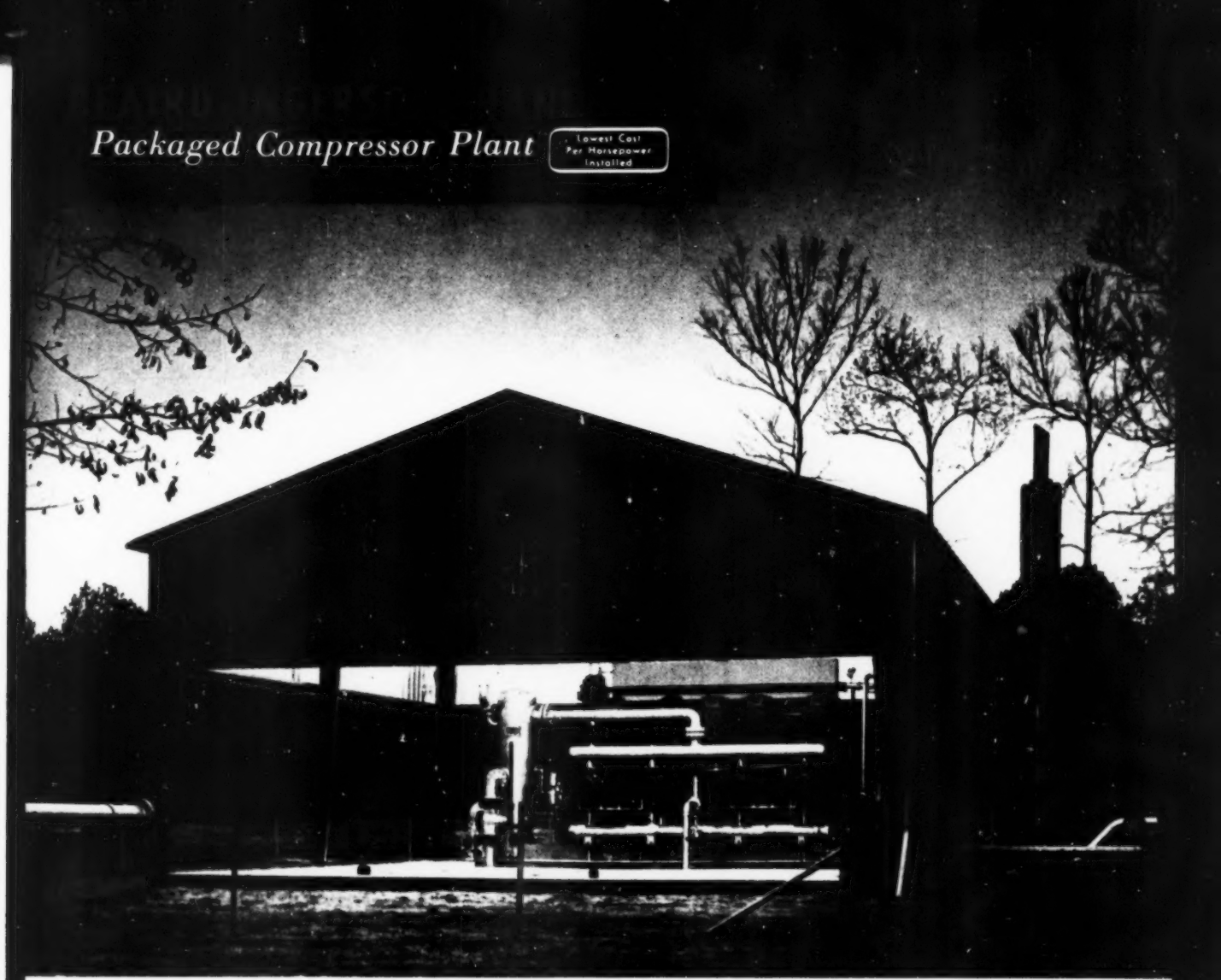
UNITED STATES RUBBER COMPANY

MECHANICAL GOODS DIVISION • ROCKEFELLER CENTER, NEW YORK 20, N. Y.

For more data on advertised products, use Readers' Service Cards, last page.

Packaged Compressor Plant

Lowest Cost Per Horsepower Installed



This packaged compressor plant is complete with Ingersoll-Rand gas engine driven compressor, Young radiator and all necessary equipment and controls. Sizes from 110 h.p. to 550 h.p.

NATURAL GAS & OIL COMPANY has a compressor station in Sligo Field, Louisiana, which is planned for maximum use of compressor horsepower throughout the life of the wells it serves. To boost gas from low pressure wells into gathering lines the company recently installed one single-stage 550 horsepower Beaird-Ingersoll-Rand packaged compressor plant. In the future, as well head pressures fall, a second 550 horsepower unit may be installed in space already provided in the same building. Later, both compressor plants may be easily converted to two-stage units. And finally, as the well is nearing depletion, one of the compressor plants may be transferred as a complete package to another site, leaving the remaining plant to complete production.

Let us show you the economy of using Beaird-Ingersoll-Rand packaged compressor plants for gas production.

Boosts field gas —

HOW ONE PRODUCER PLANNED A FLEXIBLE COMPRESSOR STATION

THE J. B. BEAIRD COMPANY, INC.

Shreveport, Louisiana

BEAIRD

MACHINING MANUFACTURING STEEL WAREHOUSE

PACKAGED COMPRESSOR PLANTS

CAST STEEL FITTINGS

PRESSURE BULK STORAGE

ANHYDROUS AMMONIA EQUIPMENT

LP-GAS SYSTEMS

BEAIRD Pressure Storage Tanks

Engineered For Safe Storage

Now ALL Beaird Tanks are X-rayed

You know the advantage of having all shell seams on pressure tanks X-rayed. And now that is standard practice on all our large LP-Gas and anhydrous ammonia tanks — not just spot X-raying — but complete X-raying of entire shell seams. For example, on each 30,000-gallon tank, over 200 separate films are exposed, developed and individually inspected. With these films, our inspectors can literally see through every inch of seam on the entire shell. They know the welding is sound.

That is why we have gone to the expense of installing the most modern radiographic equipment — to assure you that the Beaird tanks you receive are engineered and manufactured for safe storage.

Let us quote you on your pressure storage requirements.

THE J. B. BEAIRD COMPANY, INC.
SHREVEPORT, LOUISIANA

BEAIRD

MACHINING MANUFACTURING STEEL WAREHOUSE

PACKAGED COMPRESSION PLANTS

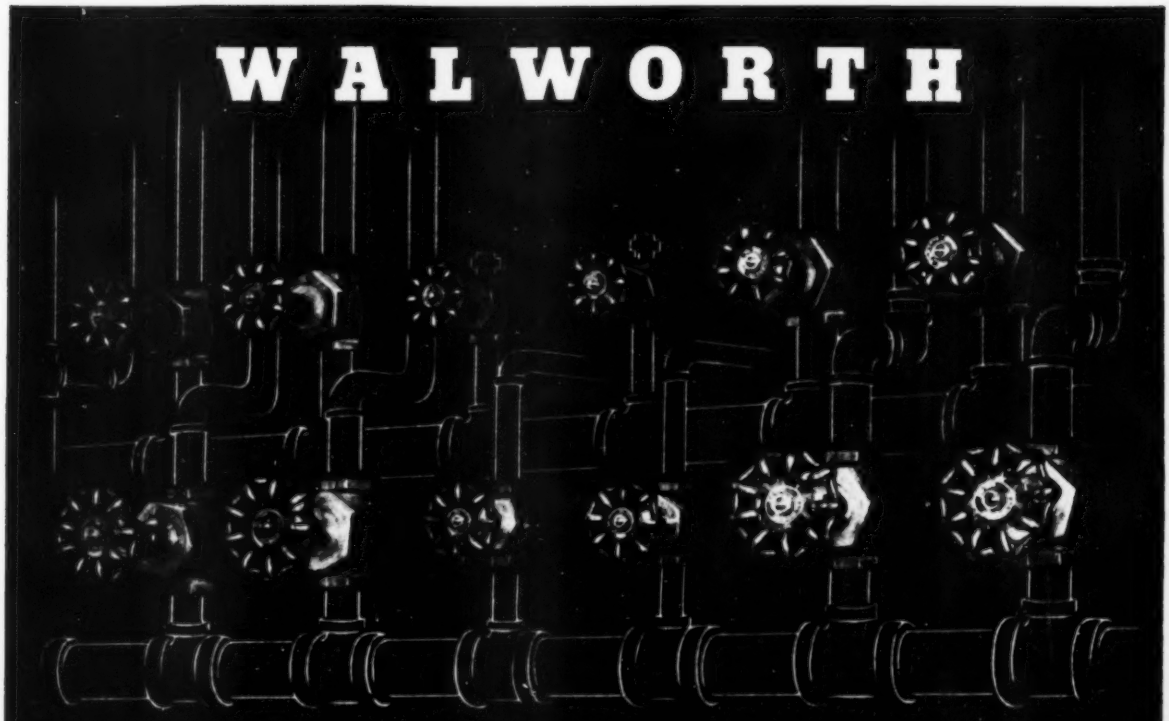
CAST STEEL FITTINGS

PRESSURE BULK STORAGE

ANHYDROUS AMMONIA EQUIPMENT

LP-GAS SYSTEMS

WALWORTH

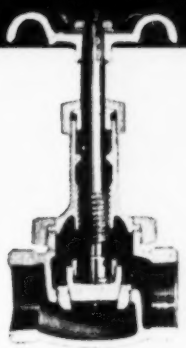


BRONZE VALVES

Better because ... **Walworth has standardized its line of bronze valves to provide an unsurpassed system of interchangeability of parts for assembly or replacement. You can maintain a great number of Walworth Bronze Valves with a small inventory of basic parts ... you minimize part replacement problems. For further information, ask us for our Bronze Valve Standardization Chart.**

Choose from complete lines of Walworth Bronze Valves – including gate, globe, angle, check, and lubricated plug types. Walseal® Bronze Valves and Fittings are also available for making silver-brazed joints.

For full information on Walworth Bronze Valves and Fittings, call your Walworth Distributor, nearest Walworth Sales Office, or write to Walworth Company, General Offices, 60 East 42nd Street, New York 17, N. Y.



Parts are carefully machined and finished to close tolerances, thereby assuring accurate fit and alignment under all conditions. Sectioned valve is Walworth No. 225P Bronze Globe Valve with stainless steel plug-type seat and disc, heat-treated to a minimum of 500 Brinell hardness.

WALWORTH

Manufacturers since 1842

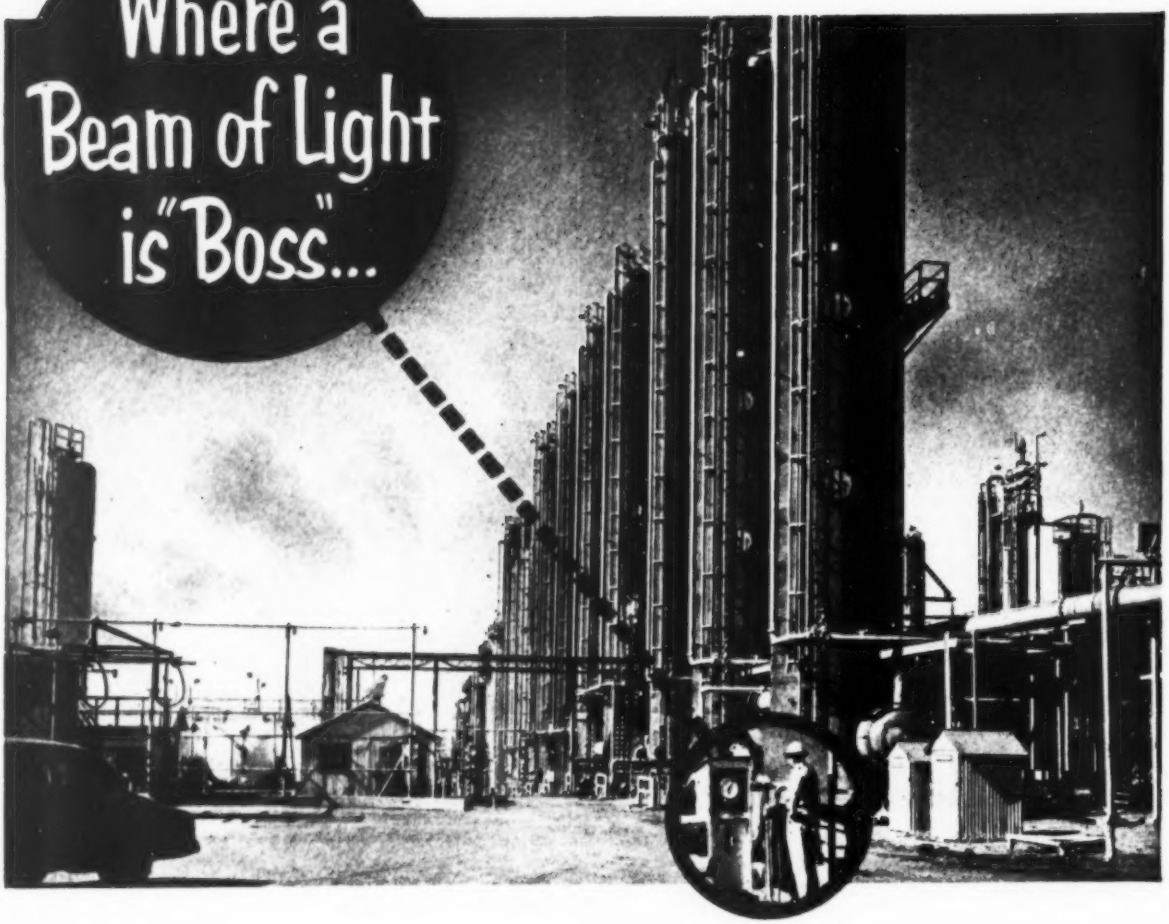
valves ... pipe fittings ... pipe wrenches

60 East 42nd Street, New York 17, N. Y.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

For more data on advertised products, use Readers' Service Cards, last page.

Where a Beam of Light is "Boss"...



Specified purity, uniformity and maximum output are maintained *automatically* on the cyclohexane column, above, by a Phillips Automatic Differential Refractometer (shown in red circle).

After years of research, development and full-scale evaluation in refinery and chemical processing, two new automatic control instruments are ready for sale or lease.

Phillips Differential Refractometers and multi-stream Infrared Analyzers are available now for immediate application to the monitoring and control of process streams.

Over 30 of these efficient, explosion-proof instruments are now increasing production and cutting costs in Phillips more important operations. Each instrument installation has paid for itself in a surprisingly short time — in some instances, even a matter of a few days.

Phillips Petroleum Company's broad experience in sampling procedure and control application is also at your service through our Instruments Sales Division.

Write today for full information.

INSTRUMENTS SALES DIVISION

PHILLIPS PETROLEUM COMPANY

BARTLESVILLE, OKLAHOMA

When something's got to give
to compensate for expansion,
contraction, vibration, rotation or strain,
in your piping system or equipment,
it will be far, far better for you
if the "something" that gives
is a Zallea Expansion Joint
and not your expensive piping.
Since piping damage usually
means down-time, it pays
to provide positive, over-all protection.

The expansion joints illustrated,
duo-equalizing, hinged, and universal,
are just a few of the Zallea family
of expansion joints available
to help solve your piping problems.

Regardless of piping movement,
whether axial, lateral, rotational,
etc., Zallea already has, or will
design, an expansion joint to absorb it.
For information on standard types,
request Bulletin 351. For consultation
on special problems, ask us to
have our representative call.

Zallea
expansion joints

ZALLEA BROTHERS, 890 LOCUST STREET, WILMINGTON 99, DELAWARE

World's Largest Manufacturers of Expansion Joints

For more data on advertised products, use Readers' Service Cards, last page.

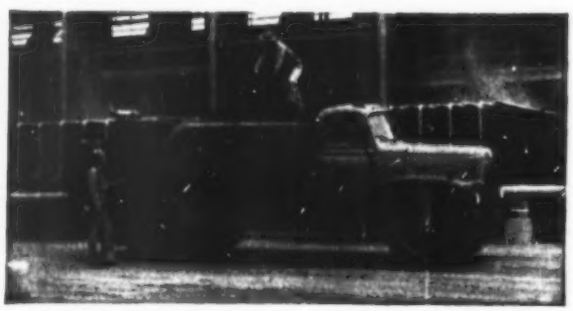
MILL SCALE REMOVED CHEMICALLY FROM NEW PLANT EQUIPMENT

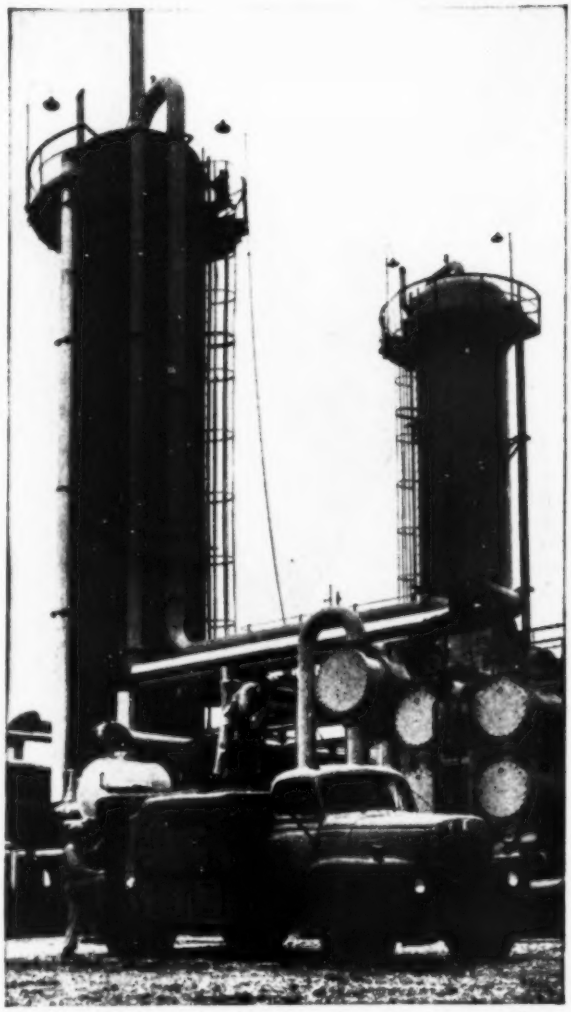
Entire ammonia plant cleaned after erection. Job done in 4 days, cutting operator's estimated cleaning cost almost 50%.

A new synthetic ammonia plant had just been erected. The operator wanted to remove the mill scale from the entire operating system before the plant was put into production. This would eliminate dangers of product contamination, retarded heat transfer and further corrosion. And once the plant was put into operation, it could stay on stream.

Dowell engineers did the job in just 4 days. They used chemical solvents to remove the mill scale from all equipment in the ammonia, oxygen and lube systems—compressors, after-coolers, intake, discharge, hydraulic and synthesis lines, nitrogen knockouts, synthesis and raschig ring towers, and ammonia bowls. Solvents were applied through regular connections—no dismantling was required.

The operator indicated that Dowell Service saved his company almost 50% over their own estimated cost of removing the scale using mechanical methods.





Dowell engineers apply their wide chemical experience to your problems.

Dowell engineers do the job for you. They bring chemical solvents in truck-mounted tanks right to the job. They furnish all necessary pumping and control equipment. Solvents are applied according to the techniques demanded by the job: filling, spraying, jetting, cascading or vaporizing. These liquid solvents go wherever steam and water flow, reaching surfaces inaccessible to other cleaning methods. No special scaffolding is required. *There is usually no dismantling, and downtime is held to a minimum.*

Perhaps chemical cleaning can help increase the efficiency of equipment in your plant. For complete information and cost estimates, call your nearest of over 130 Dowell offices—no obligation, of course. If you prefer, write directly to DOWELL INCORPORATED, TULSA 1, OKLAHOMA, Department F-31.

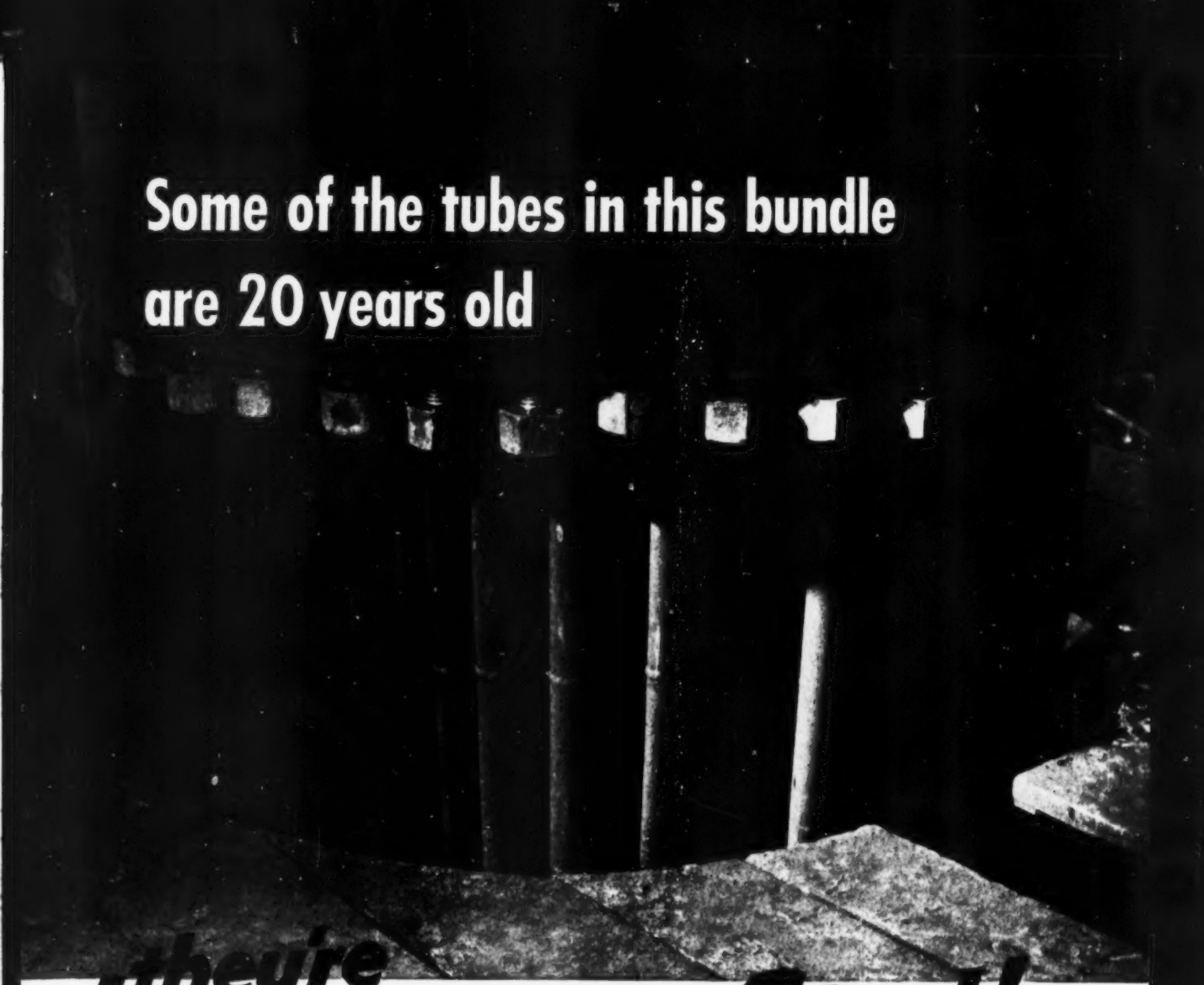
DOWELL SERVICE

chemical cleaning service for industry

DOWELL

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY

Some of the tubes in this bundle are 20 years old



...they're Stainless Steel!

This particular bundle of heat exchanger tubes is from a Thermal Cracking Unit at a major southwestern oil refinery. Some of these tubes have been handling a variety of corrosive products for more than 20 years. Yet, because they are Stainless Steel, they still get the inspector's "OK."

Stainless Steel's resistance to corrosive media frequently found in the oil made it a logical selection for this job. Its non-fouling tendencies have permitted longer runs, increased throughput, increased yields and decreased downtime.

The durability of these Stainless Steel tubes is proved by the fact that they have been removed, straightened and reinstalled. Some have been lengthened by heliarc welding on short lengths.

This is but one of many examples of the economy of using Stainless Steel in refinery operations. Its excellent corrosion and temperature characteristics, plus the freedom it gives from contamination, make it invaluable in keeping your refinery on stream.

Take advantage of the properties of Stainless Steel, and when you do, be sure it is perfected, service-tested USS Stainless Steel. For extensive data on the performance of Stainless Steels in refinery service, write for our 44-page book. Send your request to United States Steel Corporation, Room 4382, 525 William Penn Place, Pittsburgh 30, Pa.

UNITED STATES STEEL CORPORATION, PITTSBURGH · AMERICAN STEEL & WIRE DIVISION, CLEVELAND
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO · NATIONAL TUBE DIVISION, PITTSBURGH
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS STAINLESS STEEL

SHEETS · STRIP · PLATES
BARS · BILLETS

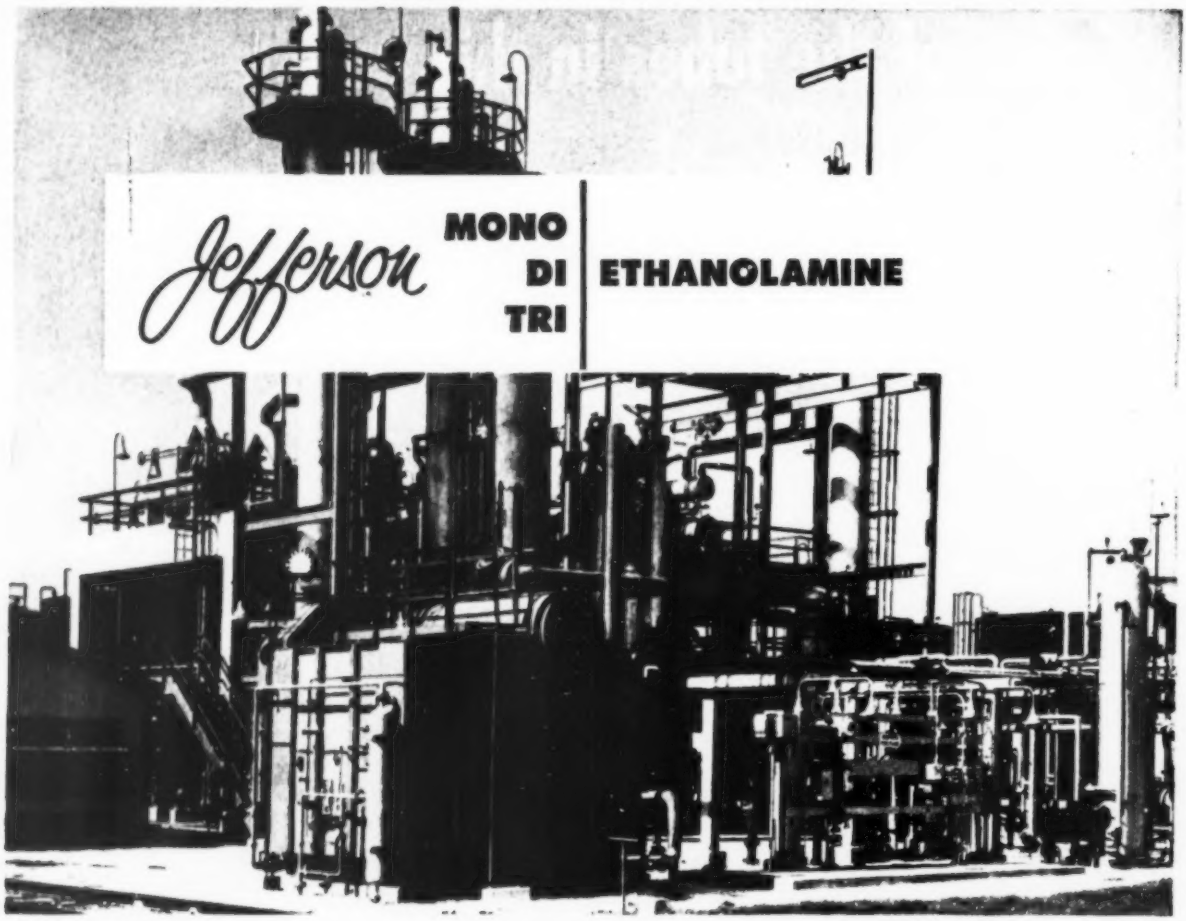
USS

PIPE · TUBES · WIRE
SPECIAL SECTIONS

4-1292

UNITED STATES STEEL

When your product depends on quality, rely on . . .



Jefferson **MONO DI TRI ETHANOLAMINE**

Jefferson Ethanolamines are made by and for chemical specialists to help improve your products and processes. They offer the performance-minded chemical manufacturer superior results in a wide variety of industrial applications that include:

- Gas treating—H_2S and CO_2 removal
- Corrosion inhibition
- Textile intermediates and softeners
- Detergents
- Cosmetic and toilet goods
- Emulsifying soaps in waxes, polishes and coatings
- Pharmaceuticals
- Rubber

and many other quality-demanding uses

Available in tank cars, tank wagons, 55-gallon drums, or in samples for your investigation. Our technical service staff will gladly assist you in your Ethanolamine applications.

Meanwhile . . . **Send for your copy of our NEW 40-page Technical Bulletin on Ethanolamines. It contains the latest information in convenient sections including:**

Shipping Information
Sales Specifications
Analytical Procedure
Physical Properties
Chemical Properties
Industrial Uses
Handling & Storage
Toxicity, and a complete Bibliography

Specialists in *essential chemicals from hydrocarbon sources*

Jefferson

CHEMICAL COMPANY, INC.

260 MADISON AVENUE, NEW YORK 16, N. Y.

Branch Sales Offices: Chicago, Illinois; Houston, Texas; Charlotte, North Carolina
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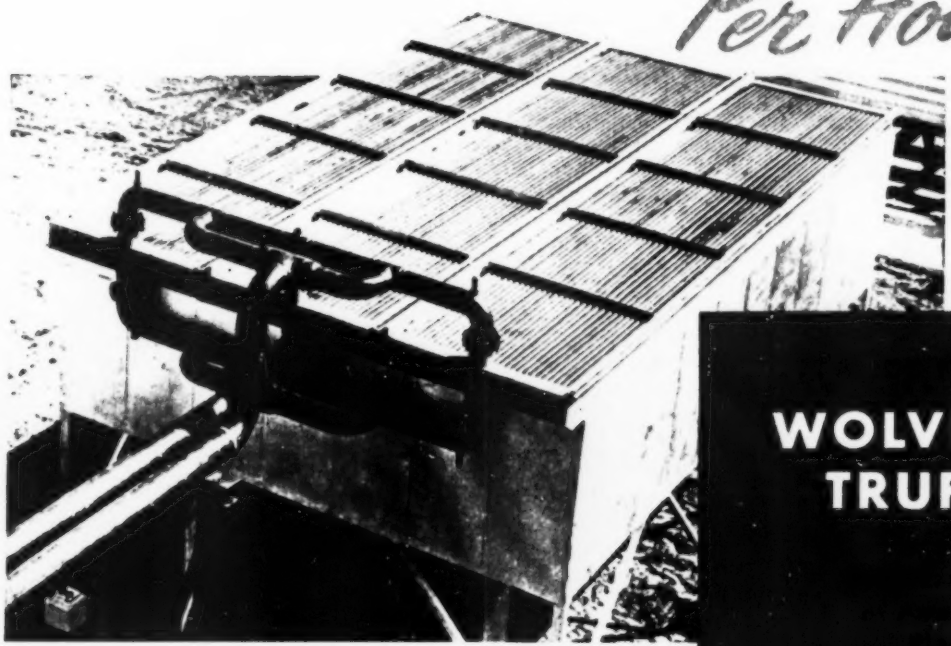
Other Stock Points: Tenafly, New Jersey; Chicago, Illinois; Houston, Texas; Charlotte, North Carolina

Ethylene Oxide
Ethylene Glycol
Ethylene Dichloride
Diethylene Glycol
Monoethanolamine
Diethanolamine
Triethanolamine
Nonyl Phenol
Morpholine
Ethylene Carbonate
Propylene Carbonate
Polyethylene Glycols
Glycol Ethers

"Get Rid of 229,400,000 BTUs Per Hour!"



WOLVERINE TRUFIN*

"Get rid of 229,400,000 BTUs per hour!"

That's the size of the job tackled by 26 Alco "Aircoolers" in the Celanese Corporation of America's plant at Pampa, Texas. Vital to the success of the installation is the role played by Wolverine Trufin Type L/C—*the bi-metal integral finned tube.*

In this application, the integral-finned aluminum tubing resists corrosion of sour gas contained in the atmosphere. At the same time, a stainless steel liner retards the corrosive action of acetic acid, methyl and ethyl acetate. The two metals are in tight mechanical bond, which provides a maximum rate of heat transfer over a long period.

The ability of Trufin to stand up under varying temperatures, vibrations and pressures is just one of the reasons for its selection in this installation.

About 220,000 lineal feet of stainless steel and 110,000 pounds of aluminum tubing comprise this Trufin installation. The 26 cooler units possess a total of 57 tube bundles—any of which can be removed by simply sliding them out of their stainless steel channel frames.

Trufin can help you, too: Yes, Wolverine Trufin—of bi-metal, copper, copper-base alloys, aluminum, electric-welded or stainless steel—can do a job for you, too! You'll find all the information you need in Wolverine's new condenser tube booklet. Write for your copy—today! WOLVERINE TUBE DIVISION of Calumet & Hecla, Inc., 1437 Central Avenue, Detroit 9, Michigan.

Wolverine Trufin and the Wolverine Spun End Process available in Canada through the Unifin Tube Co., London, Ontario

WOLVERINE TUBE DIVISION
OF CALUMET & HECLA, INC
Manufacturers of Quality Controlled Tubing

*REG. U.S. PAT. OFF.

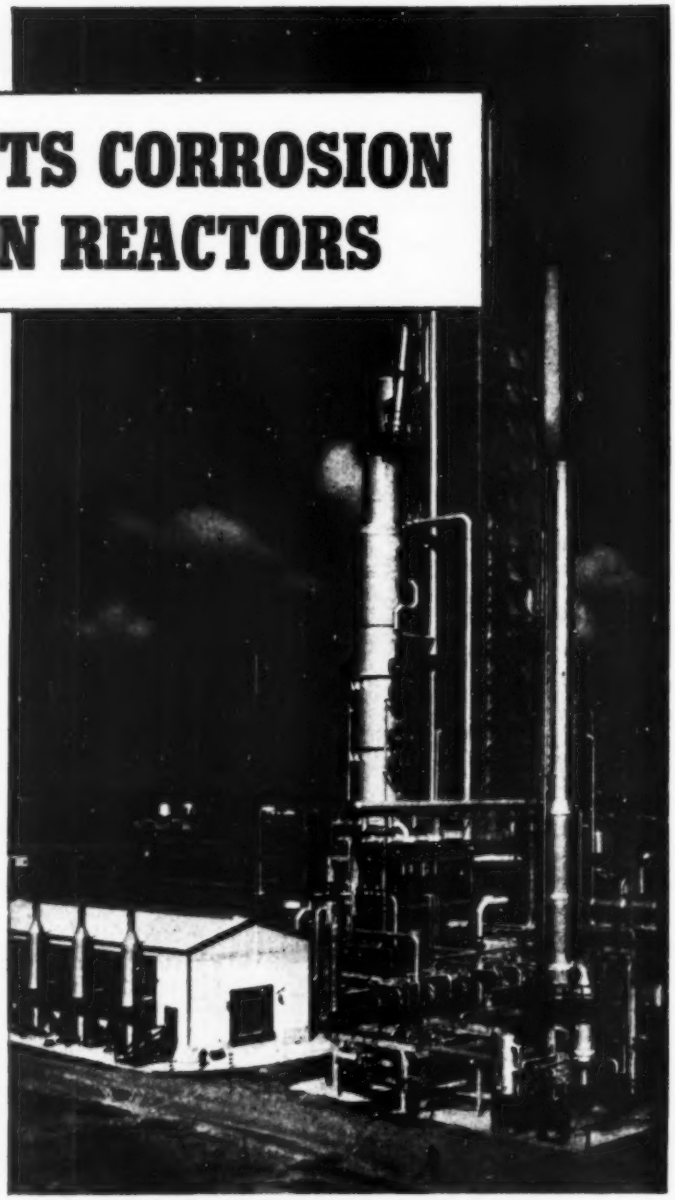
PLANTS IN DETROIT, MICHIGAN, AND DECATUR, ALABAMA SALES OFFICES IN PRINCIPAL CITIES
EXPORT DEPARTMENT 11 EAST 48TH STREET, NEW YORK 17, NEW YORK

CLAD STEEL CUTS CORROSION IN NEW TWIN REACTORS

This 25,000-barrel-per-day Houdriflow cat-cracker features twin reactor-kilns built into one large vessel for the first time. But designing this unit presented many problems. The reactor, for instance, had to resist corrosive action of the crude fraction at temperatures in the neighborhood of 950°F. To get *economical* corrosion resistance, stainless-clad steel was specified for the cone, shell and an internal head.

To get economical performance like this in other major units of this refinery, stainless-clad steel was specified for the atmospheric, vacuum and synthetic crude towers and for the flash fractionator to minimize corrosion, downtime and equipment failure. The light layer of cladding, inseparably bonded to the carbon or low-alloy backing steel, gives the performance of expensive solid high-alloy plate at much lower cost. Strength and rigidity are supplied by the backing plate.

Now this refinery is ready to meet increasingly competitive conditions as the result of an expansion program that raised operating efficiency and tripled throughput. While still in the planning stages, the refiner's engineers called on the equipment builder to help translate their ideas into the specialized equipment needed. His particular knowledge of fabricating techniques utilizing clad steel helped put this refinery ahead in output and profit. You, too, will find that it pays to consult your fabricator early in your planning for equipment that is lower in cost, longer lived and requires less maintenance.



Clad steel in this Houdriflow cat-cracker provides economical corrosion resistance at high temperatures

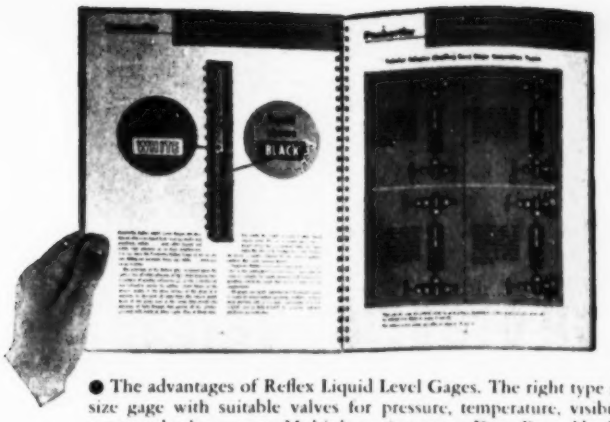
Ask one of your fabricators to show you the new Lukens clad steel movie, "Equip for New Profits." Here—in full color and sound—are factual accounts of how clad steel equipment brings new economies. The story can suggest new ideas to everyone concerned with production efficiency. Or contact Manager, Marketing Service, Lukens Steel Company, 681 Lukens Building, Coatesville, Pa.

LUKENS CLAD STEELS

STAINLESS-CLAD · NICKEL-CLAD · INCONEL-CLAD · MONEL-CLAD

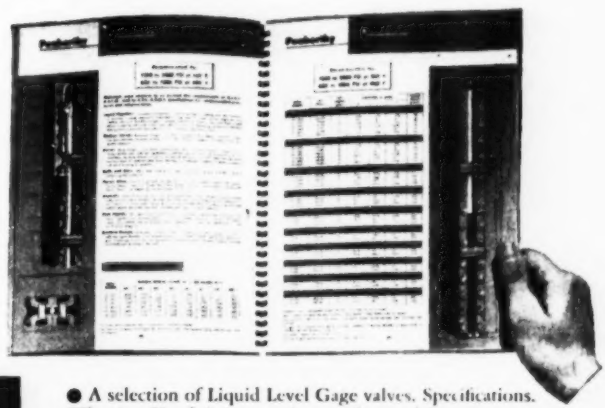
PRODUCER OF THE WIDEST RANGE OF TYPES AND SIZES OF CLAD STEELS AVAILABLE ANYWHERE

FACTS AT YOUR FINGERTIPS



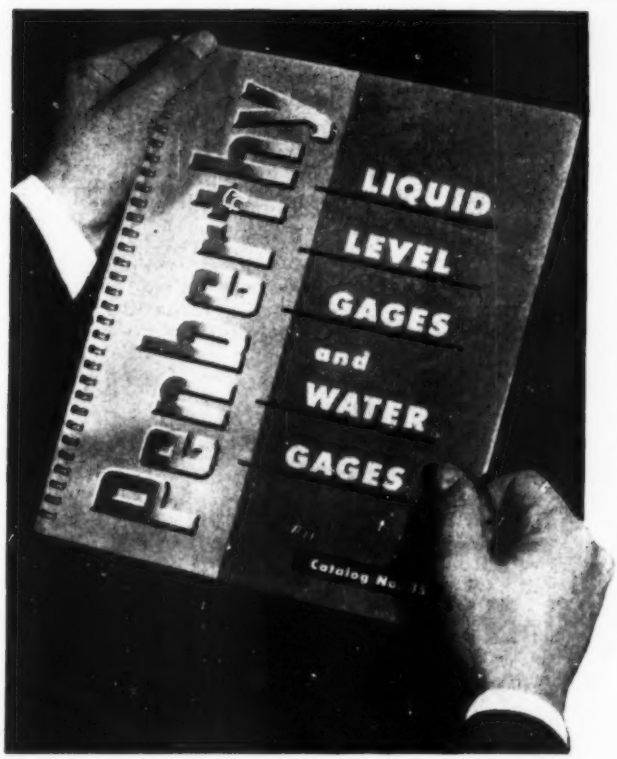
● The advantages of Reflex Liquid Level Gages. The right type and size gage with suitable valves for pressure, temperature, visibility range and valve centers. Multiple section gages. Drop Forged bodies. Pyrex glass. Basic and special designs.

● When to use Transparent Liquid Level Gage Sets. High pressure steam service. Adapters, valves, connections. Types available with recommendations.



● A selection of Liquid Level Gage valves. Specifications. "Floating Shank." Connections and special features.

● Metallurgical specifications. Gage glass and guard rods. Engineering service.



Penberthy's Catalog 35 is jam-packed with illustrated facts and specifications. It is your best guide to selecting the right liquid level gage sets at the most economical cost. In the complete Penberthy line, there are standard products for almost every application. Where your needs are special or unique, use the experience of almost 70 years to solve them. Take a tip from many thousands of satisfied users and write for your copy of Catalog 35.

Established 1886

PENBERTHY INJECTOR COMPANY

Division of the Buffalo-Eclipse Corporation

1278 Holden Ave., Detroit 2, Michigan

There's *Certain* satisfaction in products by PENBERTHY

For more data on advertised products, use Readers' Service Cards, last page.

A Service Advertisement By LUNKENHEIMER

Tips on ordering valves

Guessing can be costly when you order valves. When in doubt, give your distributor the following information, and he will recommend the right valve for your particular application:

1 Specify the size (the inside diameter of the valve-end in inches).

2 Specify the maximum pressure the valve will be subjected to.

3 Specify the maximum temperature the valve will be subjected to.

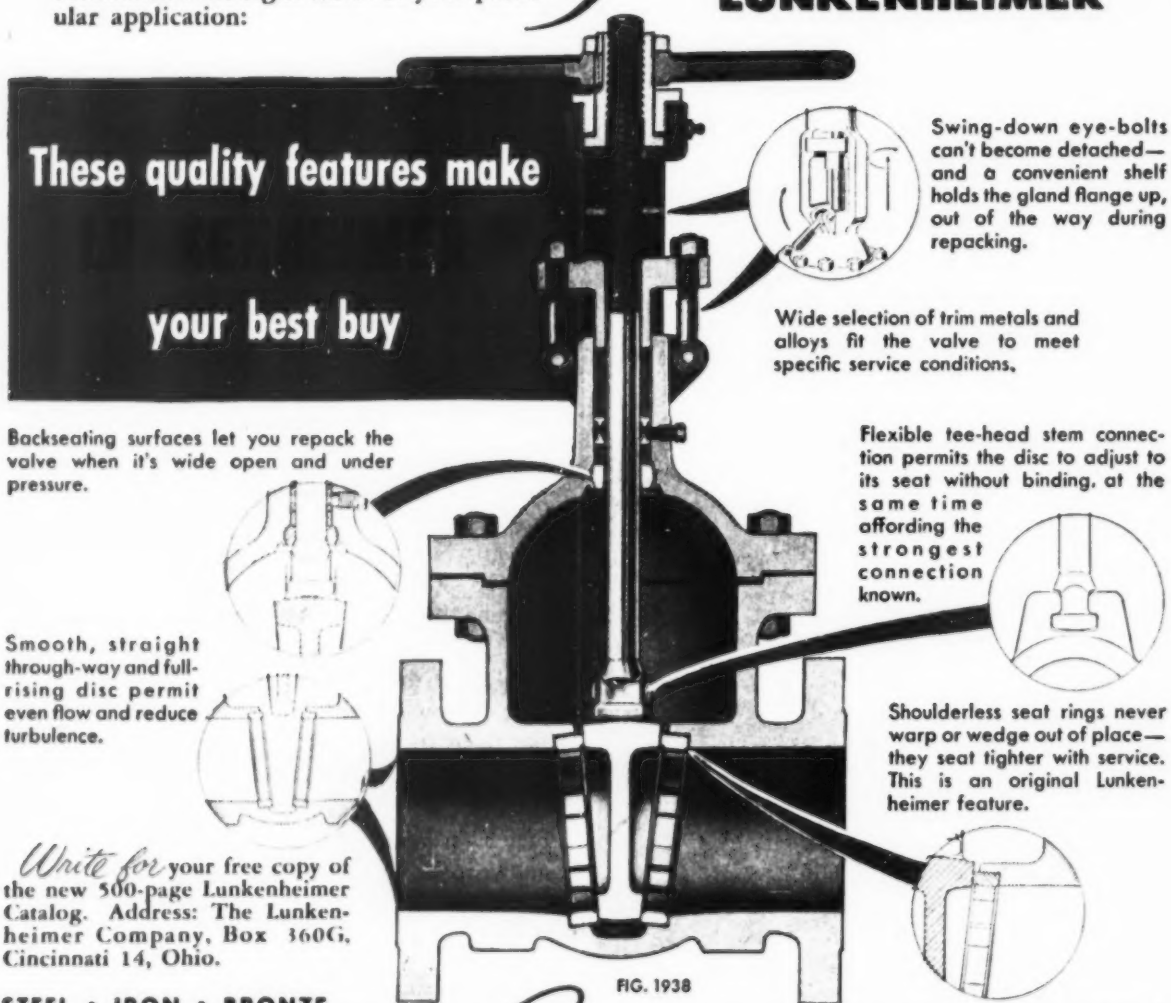
4 Specify the type of service — steam, hot or cold water, oil, gas, etc.

5 Specify any special corrosive condition the valve must stand.

6 *And for Proved-in-Service quality, specify*

LUNKENHEIMER

These quality features make your best buy



Swing-down eye-bolts can't become detached—and a convenient shelf holds the gland flange up, out of the way during repacking.

Wide selection of trim metals and alloys fit the valve to meet specific service conditions.

Backseating surfaces let you repack the valve when it's wide open and under pressure.

Flexible tee-head stem connection permits the disc to adjust to its seat without binding, at the same time affording the strongest connection known.

Smooth, straight through-way and full-rising disc permit even flow and reduce turbulence.

Shoulderless seat rings never warp or wedge out of place—they seat tighter with service. This is an original Lunkenheimer feature.

Write for your free copy of the new 500-page Lunkenheimer Catalog. Address: The Lunkenheimer Company, Box 3606, Cincinnati 14, Ohio.

FIG. 1938

STEEL • IRON • BRONZE

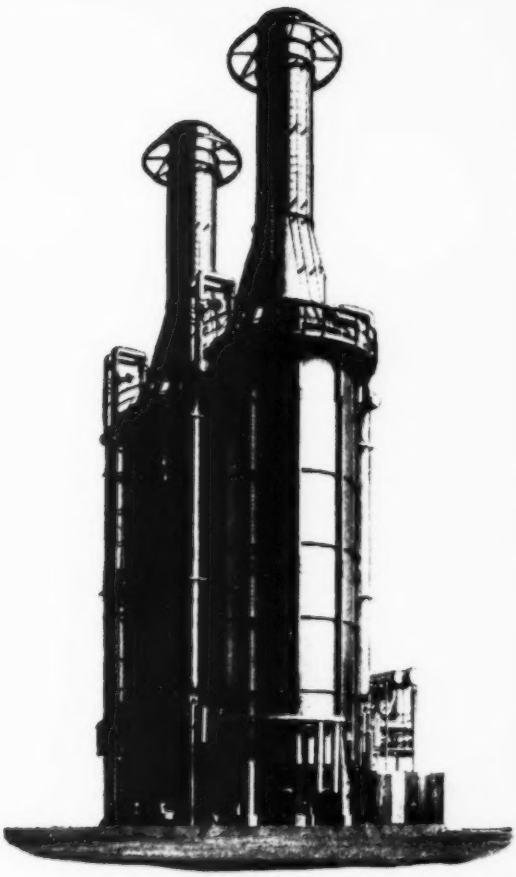
LUNKENHEIMER®

THE ONE *Great* NAME IN VALVES

E-653-11

BARRELS PER DAY
BARRELS PER DAY
BARRELS PER DAY
BARRELS PER DAY

Cat Reformers



PETROCHEM

UNLIMITED IN

PETRO-CHEM DEVELOPMENT

Representatives: Bethleham Supply, Tulsa and
Lovally, Chicago • Lester Oberholtz, Los A
Foreign Licensees: England – BIRWELCO, LTD., B

For more data on advertised products, use Readers' Service Cards, last page

A Central Storage Unit
for your Vapor Conservation System

Above: 150,000-cu. ft. Horton Vaporsphere built for the Sunset Oil Company at Torrance, California.

HORTON VAPORSPHERE

The Horton Vaporsphere® is ideal as the central storage unit of a vapor conservation system. Interconnected by large diameter vapor piping to fixed roof tanks storing volatile hydrocarbons, the Vaporsphere provides temporary storage facilities for vapor displaced by thermal expansion or filling operations.

The Vaporsphere is a spherical steel shell with a flexible hemispherical membrane on the inside that is attached to the shell at the equator. The space below the membrane is used to store the vapor when it is displaced from interconnected tanks. When conditions causing the displacement are reversed, the vapor returns to the tanks.

Further information, estimates or quotations on a Horton Vaporsphere may be obtained by writing our nearest office. There is no obligation on your part.

Above: Cutaway view of Horton Vaporsphere showing interior details.

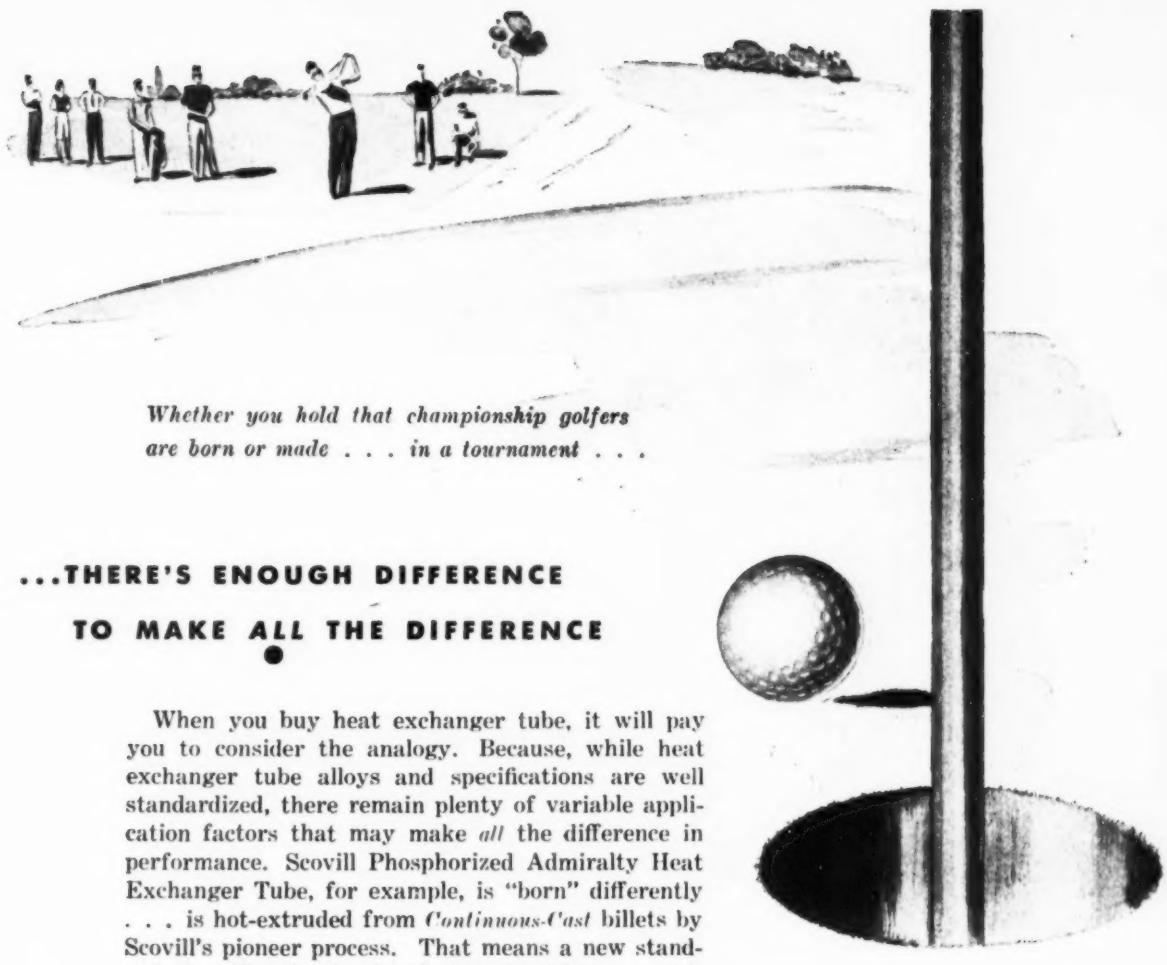
CHICAGO BRIDGE & IRON COMPANY

Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PENNSYLVANIA

Atlanta 3	2146 Healey Building	Detroit 26	1520 Lafayette Building	Pittsburgh 19	3237 Alcoa Building
Birmingham 1	1548 North Fiftieth Street	Houston 2	2126 C & I Life Building	Salt Lake City 4	531 West 17th South Street
Boston 10	1030—201 Devonshire Street	Los Angeles 17	1534 General Petroleum Building	San Francisco 4	1551—200 Bush Street
Chicago 4	2463 McCormick Building	New York 6	3302—165 Broadway Building	Seattle 1	1331 Henry Building
Cleveland 15	2234 Midland Building	Philadelphia 3	1608—1700 Walnut Street Building	Tulsa 3	1626 Hunt Building

REPRESENTATIVES AND LICENSEES

Ateliers et Chantiers de la Seine Maritime, Paris, France
Compagnia Tecnica Industrie Petroli, Rome, Italy
Constructions Metalliques de Provence, Arles-sur-Rhone, France
Chicago Bridge & Iron Company, Ltd., Apartado 1348, Caracas, Venezuela
Sociedade Chibridge de Construcoes Ltda., Av. General Justo, 275, Grupo 306, Rio de Janeiro, Brazil
Horton Steel Works Limited, Fort Erie, Ontario, Canada
Motherwell Bridge & Engineering Company, Motherwell, Scotland
Whessoe Limited, Darlington, England
Comprimo N. V., 21, Amstel, Amsterdam (C) Netherlands



Whether you hold that championship golfers are born or made . . . in a tournament . . .

. . . THERE'S ENOUGH DIFFERENCE TO MAKE ALL THE DIFFERENCE

When you buy heat exchanger tube, it will pay you to consider the analogy. Because, while heat exchanger tube alloys and specifications are well standardized, there remain plenty of variable application factors that may make *all* the difference in performance. Scovill Phosphorized Admiralty Heat Exchanger Tube, for example, is "born" differently . . . is hot-extruded from *Continuous-Cast* billets by Scovill's pioneer process. That means a new standard of uniformity in chemical composition . . . with optimum, uniformly distributed, controlled phosphorus content. It means sound metal — smooth, dense, free from pits or porosity. Such important differences in this and other Scovill Tube Alloys can make all the difference in efficient, economical service under tough operating conditions.

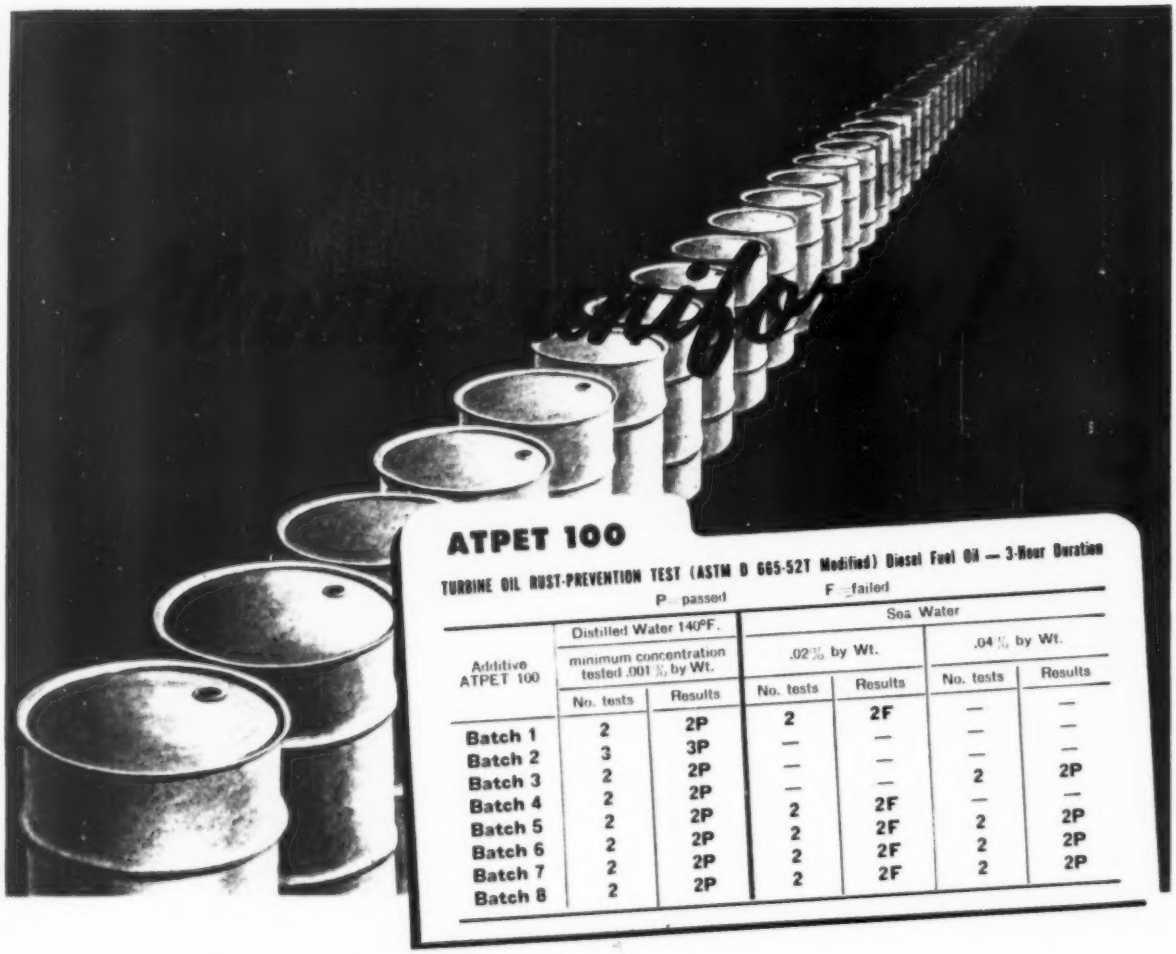
You will also find equally important differences in Scovill's unrivaled Heat Exchanger Tube Technical Services. Ask us to prove it on your next new installation or re-tubing job. The Scovill Manufacturing Company, 99 Mill Street, Waterbury 20, Connecticut. Phone Waterbury 4-1171.

SCOVILL
HEAT EXCHANGER TUBE

Phosphorized Admiralty ★ Admiralty ★ Arsenical Admiralty ★ Muntz Metal ★ Naval Brass ★ Red Brass, 85% ★ Deoxidized Copper Arsenical Copper ★ Copper Nickel, 10% & 20% ★ Cupro Nickel, 30% ★ Aluminum Brass ★ Aluminum Bronze, 5% ★ Duplex Tube

6SC54

For more data on advertised products, use Readers' Service Cards, last page.



ATPET 100

TURBINE OIL RUST-PREVENTION TEST (ASTM D 665-52T Modified) Diesel Fuel Oil — 3-Hour Duration

P—passed F—failed

Additive ATPET 100	Distilled Water 140°F. minimum concentration tested .001 % by Wt.		Sea Water .02% by Wt.		Sea Water .04 % by Wt.	
	No. tests	Results	No. tests	Results	No. tests	Results
Batch 1	2	2P	2	2F	—	—
Batch 2	3	3P	—	—	—	—
Batch 3	2	2P	—	—	—	—
Batch 4	2	2P	—	—	2	2P
Batch 5	2	2P	2	2F	—	—
Batch 6	2	2P	2	2F	2	2P
Batch 7	2	2P	2	2F	2	2P
Batch 8	2	2P	2	2F	2	2P

ATPET 100® non-metallic corrosion inhibitor

Batch after batch, ATPET 100 rust inhibiting oil additive produces the same high effectiveness. Completely non-metallic, ATPET 100 is applicable for use in slushing oils, engine preservatives, turbine oils, #2 fuel oils and other compounds for which high corrosion preventative action is desired. Tests made in the Atlas laboratories in accordance with military specifications prove its effectiveness even when used in small concentrations. It's a 100% active material. And it is economically priced. Write for test samples and full technical information.

INDUSTRIAL CHEMICALS DEPARTMENT

ATLAS POWDER COMPANY

WILMINGTON 99, DELAWARE

offices in principal cities

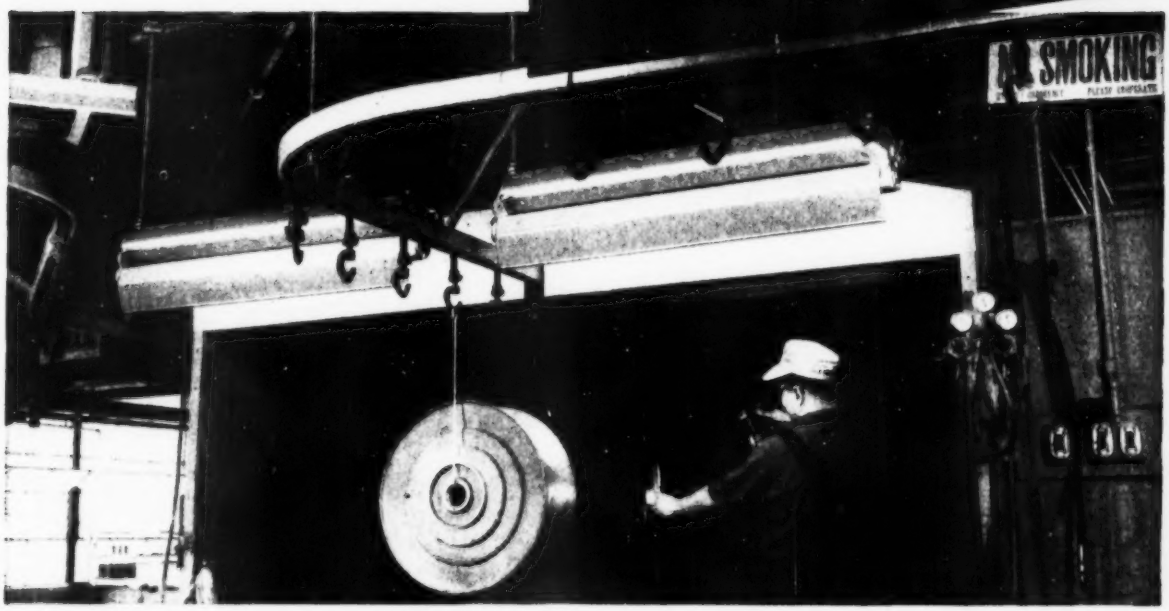
ATLAS POWDER COMPANY, CANADA, LTD.
BRANTFORD, CANADA

NOW . . . a NEW Rapid Start BALLAST

for longer lamp and ballast life

plus quiet, flickerless operation

"EFU" Explosion Proof



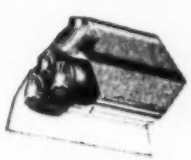
BRIGHT, SAFE ILLUMINATION FOR HAZARDOUS LOCATIONS

Complete protection against explosion hazards from lighting equipment is afforded this spray area through the use of APPLETON "EFU" Fixtures. Convenient angle mounting sheds light directly and evenly on the work area. Hazardous locations in refineries, grain mills, color printing plants, chemical plants, pharmaceutical concerns, etc., may be protected in the same manner.

● FOR SAFETY AND SAVINGS, specify *APPLETON "EFU" Explosion-Proof Fluorescent Fixtures and Fittings* . . . a complete quality line from one dependable source. Three different high power factor ballasts are available now, including a new "Rapid Start" for long lamp life, long ballast life without starters, and quiet, flickerless operation. Re-lamping is permitted from either end of fixture, and the APPLETON factory seal eliminates external seals normally required within 18 inches of arcing devices. Whatever the lighting problem, an APPLETON "EFU" installation assures maximum safety, high light output and trouble-free economical service.

Sold Nationally
Through Electrical Wholesalers

2, 3 and 4-Lamp Fixtures . . . Straight or Angle Mounting



2-Lamp Fixture

NEW

3-Lamp Fixture

NEW

4-Lamp Fixture

Choice of "Pre-Heat," "Slimline" or new "Rapid Start" ballasts. Designed for use with 40-Watt, 48-inch, T-12, and 85, 90 or 100-Watt, 60-inch, T-17 fluorescent lamps. End housings are cast aluminum with line connections made to a terminal block in the junction chamber.

APPLETON ELECTRIC COMPANY
1732 Wellington Avenue • Chicago 13, Illinois

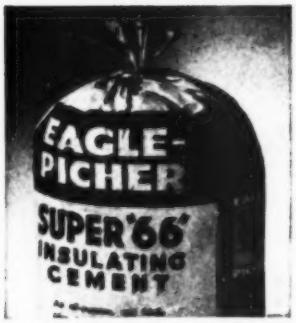
APPLETON ELECTRIC PRODUCTS REG. U.S. PAT. OFF.

Also Manufacturers of:

Rely on **APPLETON** *. . . The Standard for Better Lighting*

For more data on advertised products, use Readers' Service Cards, last page.

EAGLE-PICHER "Super 66" Insulating Cement



Conforms to Commercial Standard CS-117

Because Eagle-Picher Super "66" Insulating Cement *really sticks*, it has money-saving advantages that are apparent the minute your crew begins to apply it.

Because *it sticks*—less time is wasted in application—it stays where you put it whether the equipment is heated or temporarily out of service. It "holds together" — usually no reinforcing needed on applications up to 1½ inches thick.

Because *it sticks*—Super "66" can be used effectively, economically on all types of surfaces—flat, curved, overhead—anywhere you need insulation. It's truly an all-purpose cement.

And—Super "66" is rust-inhibitive—cannot cause corrosion–actually helps prevent corrosion of costly equipment.

If you've never tried Eagle-Picher Super "66," it will pay you to learn more about it today!

"Springy Ball" structure—*the secret of the high thermal efficiency of Super "66." These small, resilient pellets of mineral wool, each one honeycombed with thousands of minute air cells, effectively resist the flow of heat even when used on equipment heated to 1800 F.*

Since 1843

EAGLE EP PICHER

THE EAGLE-PICHER COMPANY

General Offices: Cincinnati (1), Ohio

For greater efficiency, protection and economy, you should investigate these Eagle-Picher products: Insulating Felts • Insulating Block • Blankets • Loose Wool • Mineral Wool Pipe Covering • Stalastic Stamastic • Insulseal • Finishing Cements • Insulating Cements • Swetchek • Insul-Stic • Fireproofing Cement

Member of Industrial Mineral Fibre Institute

For more data on advertised products, use Readers' Service Cards, last page.

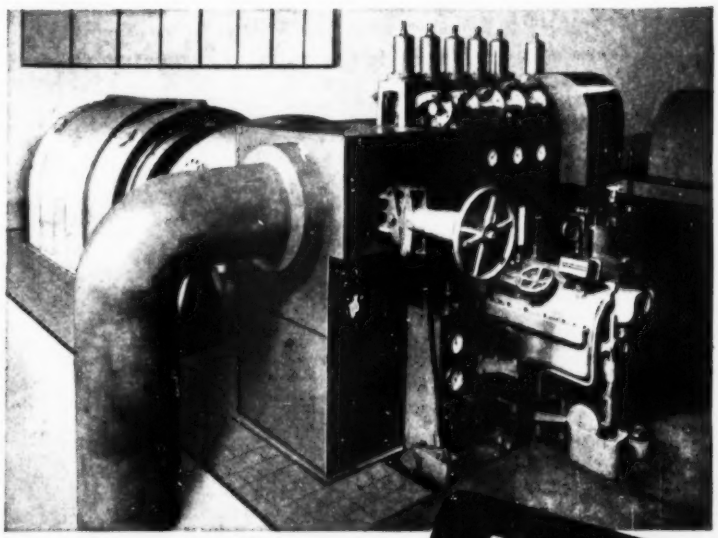
How a Southern Paper Company

Cuts Power Costs Three Ways

1
Eliminates Tube Failure

2
Reduces Maintenance

3
Cuts Blowdown Requirements



Main turbine room contains five turbine-generator units. You can get complete information on silica removal by writing for a copy of Bulletin 28R7135.

In a 33-month period, a southern paper company replaced 133 tubes and welded others. Now, after installation of Allis-Chalmers water conditioning, tube failures have been completely eliminated — along with virtual elimination of unscheduled maintenance. In addition, boilers have operated at top rating and efficiency for 12 months between scheduled cleanings. Blowdown requirements have become approximately half what they were before.

Remove Silica Content in Boiler Water

The job was done by reducing silica content 94% through use of a water conditioning system designed by Allis-Chalmers water conditioning experts. Before installation, silica content averaged 43.6 ppm. Now it averages 2.7 ppm. Equipment includes a 24,000-gph hot process softener, three 10-ft *Anthrafilt* filters, a surge tank, and chemical feeder. The system has been improved since original installation by the addition of a secondary hot phosphate unit.

ALLIS-CHALMERS

Equipment — Chemicals — Service

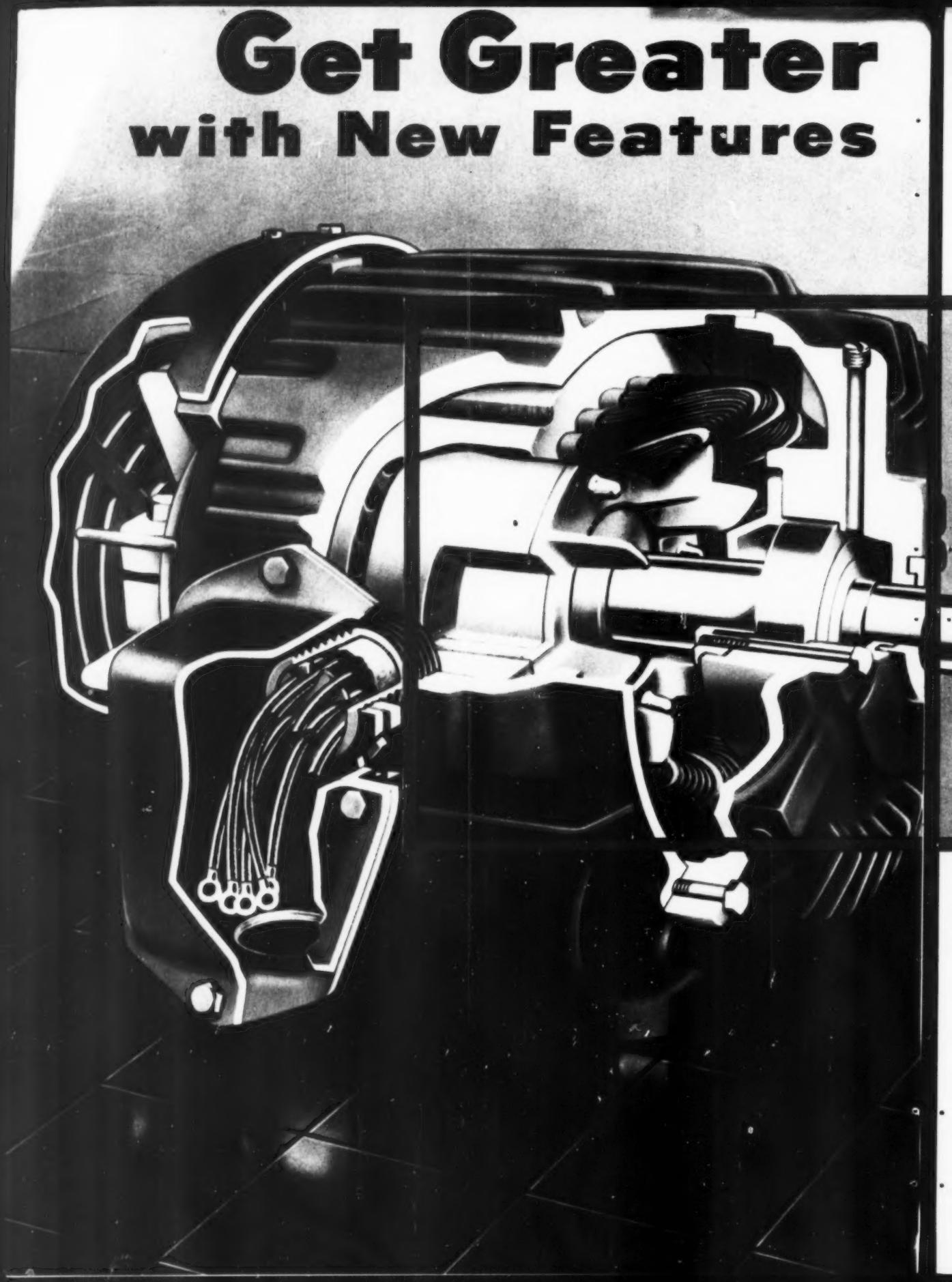
How You Can Solve Your Water Problems

For any water problem, you'll find Allis-Chalmers chemicals, service, and equipment a useful addition to your power or process water application. Years of experience combined with a complete line of equipment enable Allis-Chalmers water conditioning experts to recommend sound, economical solutions to your problems. For help with your water conditioning, call the Allis-Chalmers district office nearest you or write Allis-Chalmers, Milwaukee 1, Wisconsin.

A-4200

ALLIS-CHALMERS

Get Greater
with New Features

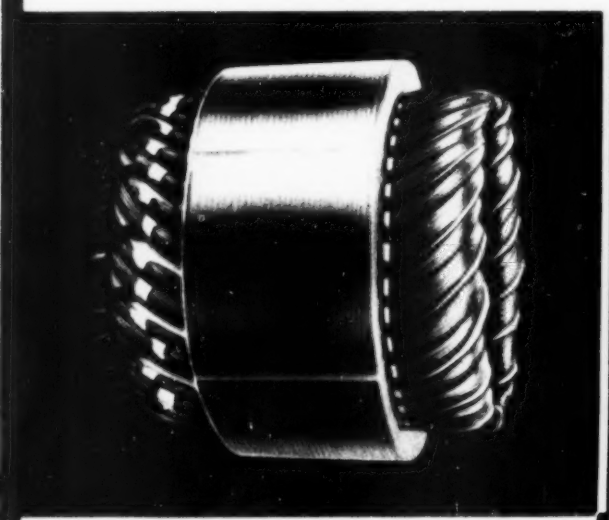


Motor Economy
. . . Proved Principles

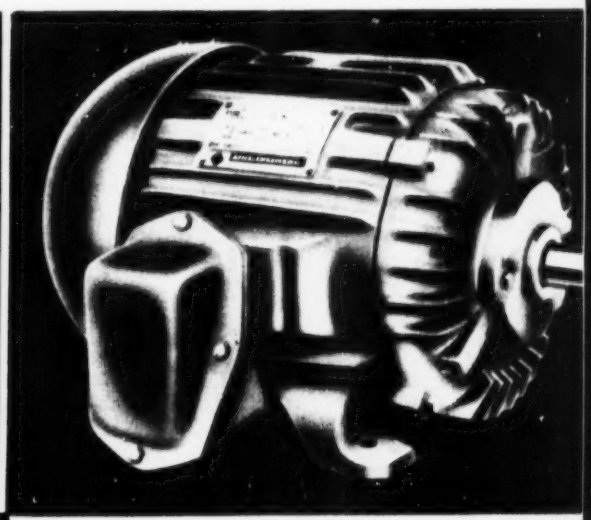
Here's the inside story of a great new motor. It combines the best of the new developments in methods and materials with the best of the tried and proved principles that have made such an outstanding record for Allis-Chalmers motors.

Smaller in size than previous design, it retains the easy-to-clean, fin-type construction which Allis-Chalmers pioneered several years ago. The bearing design gives greater bearing protection, ease of maintenance and long life. Insulation gives you famous Allis-Chalmers rugged dependability.

Consult your nearby Allis-Chalmers Authorized Distributor or District Office on your motor needs. Or write for Bulletin 51B6210.



STATOR DOUBLE INSULATED—Stator laminations are welded across back for rigidity. Heavy varnished cambric insulation is inserted between phase windings. Wound stator is dipped several times in special insulating varnish of proved effectiveness and stamina, and baked after each dip. The Allis-Chalmers stator is both physically and electrically strong . . . thoroughly protected against moisture, heat and corrosion.



FIN-TYPE CAST-IRON FRAME — Proved by years of service. Cooling ribs are cast integrally with the yoke; air is blown over them without restriction. There are no enclosed external air passages to clog up with dirt and thereby ruin cooling efficiency. Radiating surface provides reserve cooling capacity for extra strenuous duty. Cleaning, if required, is a few moments work with an air hose, brush or vacuum cleaner.

Multiple bearing protection keeps grease in... keeps dirt out...permits relubrication in service

Extreme care has been taken to provide longest possible bearing life and lowest possible maintenance costs. The bearing itself is of double-shielded type, which allows controlled migration of grease in and out of the bearing to suit operating conditions. Yet bearing is protected against greatest cause of bearing trouble — overgreasing.

Close running clearances and double labyrinth seals between the shaft and outer bearing housings keep grease in the bearing and exclude dirt. Grease is kept out of the interior of the motor by a bearing cap with a long running clearance along the shaft. The cap is held tightly in place by hex head cap screws. Large grease chambers hold an ample supply of lubricant.

A-4363

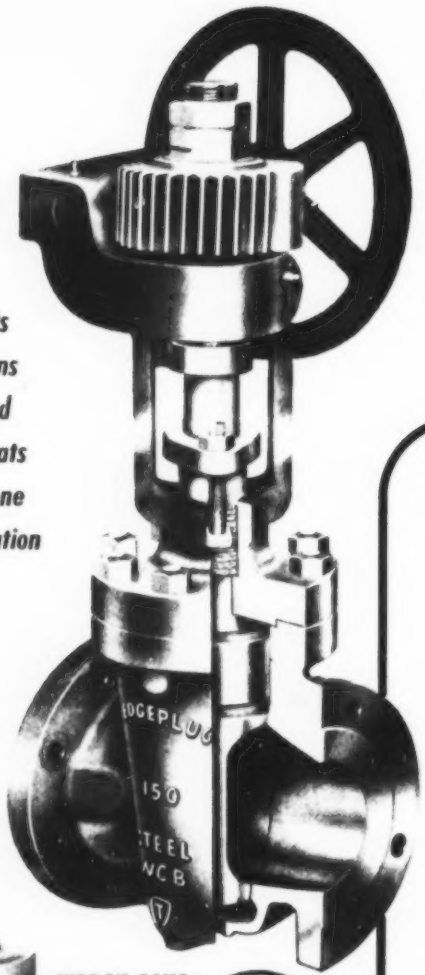
ALLIS-CHALMERS

MILWAUKEE 1, WISCONSIN

for general service...

WEDGEPLUG
STEEL DRY PLUG VALVES

lifts turns and reseats in one operation



for special service...

WITH COATED PLUG

Wedgeplug Steel Valves, equipped with our Special-Coated Plug, are setting new standards for valve performance. The Special Coating, which is bonded to the metal, assures a tight seal, and is highly resistant to abrasion and corrosion. Ideal for handling Petroleum Oils, Liquefied Petroleum Gases, Gasoline, Kerosene, Air, Gas, Water, Vegetable Oils, Animal Fats, Alcohols, Turpentine, Acid Solutions, Alkaline Solutions, Saturated Salt Solutions, and many Solvents and Chemicals. . . . Recommended for operating temperatures between —40 and + 200 F.

Available from Stock, with *Hycar-Coated Plug

MADE IN THREE TYPES: WRENCH-OPERATED HANDWHEEL-OPERATED • GEAR-OPERATED

*Hycar is the trade name of the Product, made by B. F. Goodrich Chemical Co., used in coating Plug

WEDGEPLUG VALVE COMPANY, INC.

NEW ORLEANS 15, LA.

An Affiliate of

STOCKHAM VALVES & FITTINGS

GENERAL OFFICES AND PLANT • BIRMINGHAM 2, ALA.

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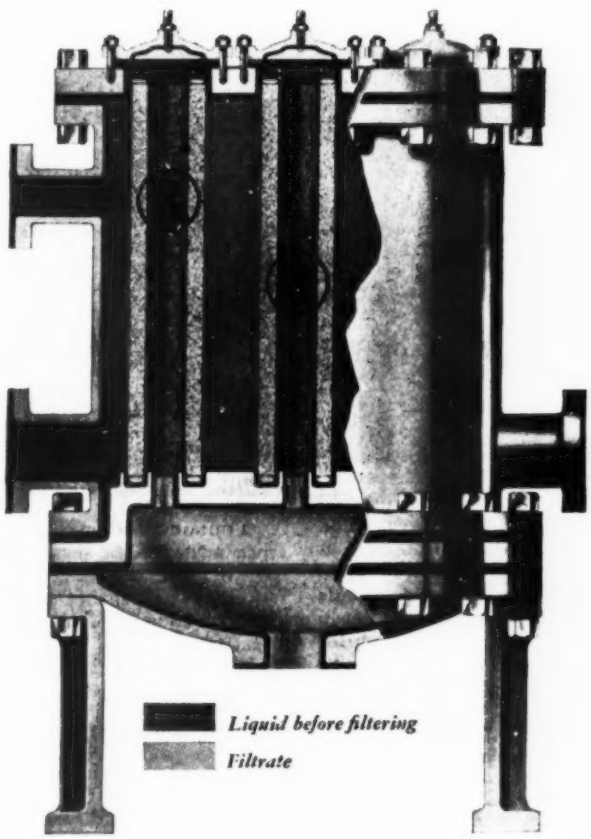
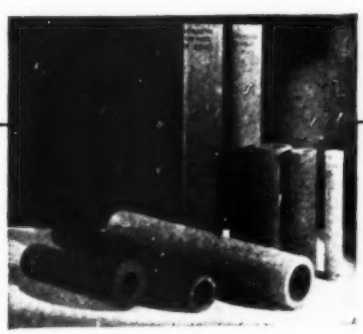
Write for* WEDGEPLUG *Catalog

DISTRIBUTED THROUGH WHOLESALERS

Another Norton R *on the job!*

Outstanding performance of Adams filters aided by Norton seamless porous tubes





R. P. Adams Co. Filters, covering many chemical filtering services, deliver sparkling clear filtrate and insure quick cleaning without disassembly. Adams filters handling acid or neutral solutions are equipped with Norton seamless porous tubes, *engineered and prescribed* for faster, more thorough filtering and backwashing.

Besides assuring fast, thorough filtering action, Norton porous tubes are extremely easy to clean by backwashing. Here are several good reasons why they excel in these two primary essentials of efficient, economical filter performance:

- Norton porous tubes are made of ALUNDUM* (fused alumina) *engineered* by Norton for chemical stability, inertness and other properties necessary to withstand acid, neutral and slightly alkaline liquors.
- Like all Norton ALUNDUM porous mediums they are made with the patented *controlled structure* process that assures even distribution of pores — for uniform passage of both filtering and backwashing liquids.
- They are *seamless,* providing unobstructed diffusion over their entire area — for further efficiency in both filtering and cleaning.

Other big advantages

of all Norton porous mediums include ease of installation and exceptional resistance to breakage and chipping. Available in sizes and open-pore ratios to meet your needs, they're *engineered* to last longer and cut your operating costs — and they're *prescribed* for a wide variety of chemical services, such as filtering water or solvents . . . cutting oils, wine, etc. . . . reclaiming cleaning fluids and industrial waste . . . and for boiler feed water treatment.

See your Norton Representative for further facts or write, describing your requirements, to NORTON COMPANY, 465 New Bond St., Worcester 6, Mass. *Canadian Representative:* A. P. Green Fire Brick Co., Ltd., Toronto, Ontario.

NORTON

REFRACTORIES

Engineered . . . Rx . . . Prescribed

Making better products . . . to make other products better

*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries

For more data on advertised products, use Readers' Service Cards, last page.

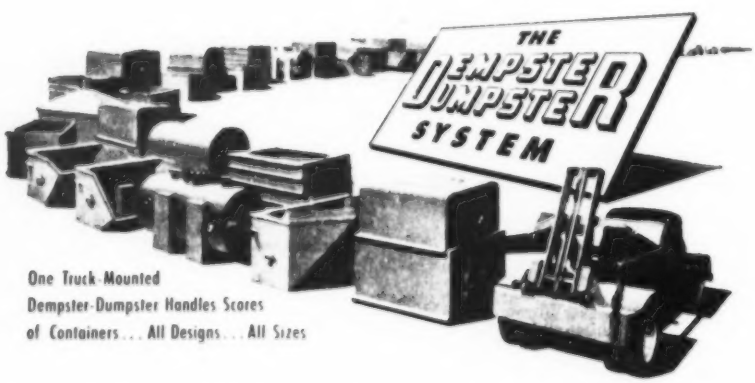
Here's a One-Man Bulk Materials Handling System for Your Plant...

In the Dempster-Dumpster System of bulk materials handling only one man, the driver of the truck-mounted Dempster-Dumpster, is required for operation. The Dempster-Dumpster serves scores of detachable Dempster-Dumpster Containers. Container capacities range up to 4 times that of conventional dump truck bodies and each container is designed to suit the materials to be handled—be they solids, liquids or dust . . . hot or cold . . . bulky, light or heavy. You simply place these containers at convenient materials accumulation points inside or outside buildings. When loaded each container is picked up, hauled and emptied (as shown above) or load set down intact. Entire operation is handled by hydraulic controls in cab.

Containers shown below are just a few of the many available or that can be built to meet your needs. They enable you to handle, at tremendous savings, materials of many descriptions—trash and waste materials, raw materials, finished products, etc. —with only one truck and only one man, the driver.

Without question, the Dempster-Dumpster System is the most economical and most efficient method of plant materials handling by truck ever devised!

Write to us for complete information. Manufactured exclusively by Dempster Brothers, Inc.



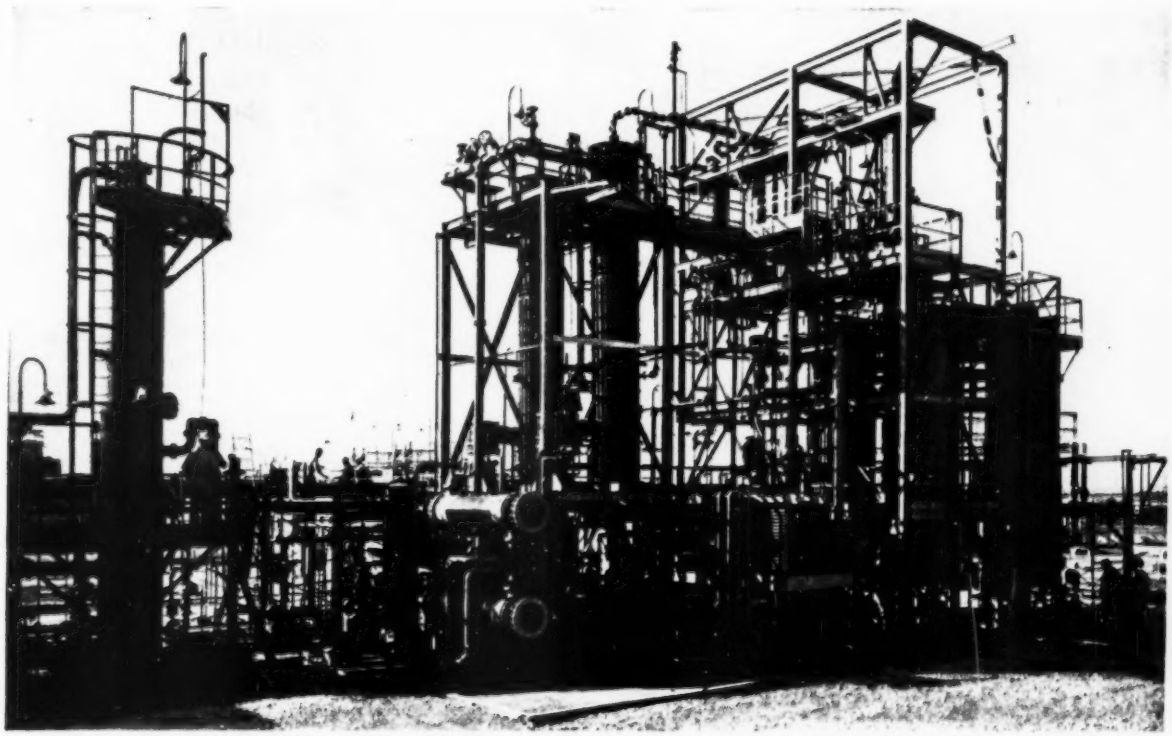
One Truck-Mounted
Dempster-Dumpster Handles Scores
of Containers . . . All Designs . . . All Sizes

DEMPSTER BROTHERS, 564 Dempster Bldg., Knoxville 17, Tennessee

WHERE HAVEG EQUIPMENT IS INSTALLED

TRADE MARK REG. U. S. PAT. OFF.

PIPING • VALVES • FITTINGS • PRESSURE PROCESS TANKS • ABSORBERS AND SCRUBBERS
HEAT EXCHANGERS • FUME DUCT • PUMPS • VACUUM JETS AND CONDENSERS



A recent petroleum chemicals plant designed and built primarily around the use of Haveg—a basic construction material that resists corrosion.

Petro-Chemical Corrosion has been Controlled!

Now for designers and engineers of petro-chemical plants there is an old and proven basic material of construction, borrowed from its 22 years of service in the chemical and metallurgical industries. It is Haveg, a plastic molded in the form of finished process equipment, or available for many types of field fabrication. Made from acid-digested asbestos and special thermosetting resins, Haveg enables you to go into a high range of process temperatures with complete safety and a proven history of outstanding performance.

Haveg has three great virtues. It is completely resistant to most corrosion. It lasts for years. It is amazingly versatile.

Not a coating or lining, Haveg gives resistance to corrosion through its entire mass, never allowing corrosives an opening wedge from cracks. It resists thermal shock, seldom requires insulation.

From steel-jacketed pressure process tanks down to the last piece of pipe, many of the petro-chemical processes can be completely contained and kept free from corrosion. Unnecessary maintenance, controls, headaches are avoided. Should plans or processes change, Haveg equipment can be machined and altered by your men, on the job. Accidental mechanical damage is easily repaired, using Haveg cement. Full chemical resistance is maintained.

If your job is fighting corrosion, get a helping hand from Haveg. Call the experienced sales engineer listed. Write for the 64-page illustrated Bulletin E-6 which contains size and chemical resistance charts, design specifications. Remember, Haveg is a logical answer to your design problems in handling petro-chemicals; in fact, in all process equipment that must handle corrosives.

ATLANTA, Exchange 3821 • CHICAGO 11, Delaware 7-6088
CINCINNATI 36, Sycamore 2600 • CLEVELAND 20, Washington 1-8700
DETROIT 35, Broadway 3-0880 • HOUSTON 4, Jackson 6840
LOS ANGELES 14, Mutual 1105 • SEATTLE 7, Hemlock 1351
ST. LOUIS 17, Mission 5-1223 • WESTFIELD, N. J., Westfield 2-7383

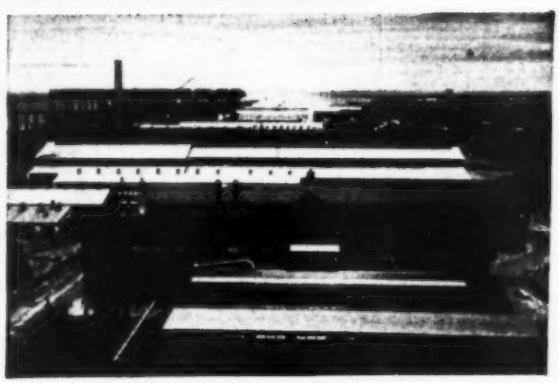
HAVEG CORPORATION
NEWARK 4, DELAWARE

TRADE MARK REG. U. S. PAT. OFF.

FACTORY: MARSHALLTON, DEL. • Wilmington 3-8884

A SUBSIDIARY OF CONTINENTAL-DIAMOND FIBRE CO.

For more data on advertised products, use Readers' Service Cards, last page.



A Mile of Shops – Each shop is devoted to a special type of heavy production. Included are complete Machine Shops, casting, forging and other facilities which offer all of the advantages of the execution of the complete job.

A half mile of pressure vessels

These are two of seventy – over ½ mile – of 38½-foot vacuum tank casings built to meet the quality requirements of a well-known processor.

The buyer also benefits from many savings made possible by Newport News extensive heavy fabrication equipment and the sixty years experience in using it.

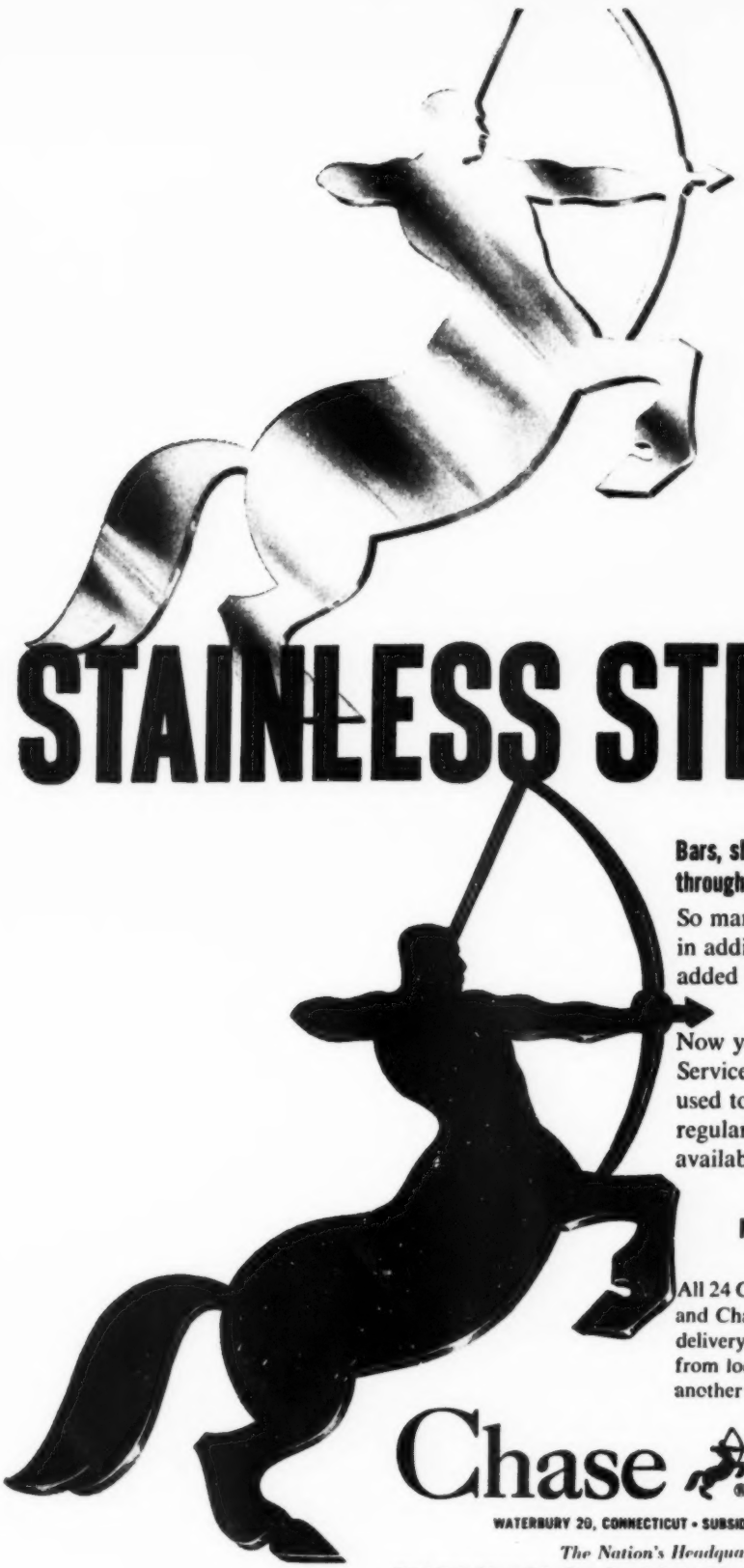
Do you plan installations of heavy production equipment? You can command the services of Newport News for weldments of corrosion-resistant, alloy and clad metals in almost any size or shape, plus the required engineering background and complete welding and stress-relieving skills.

It will pay you to get the facts, shown in *Facilities and Products*. As you glance at its photos and brief captions, you'll see why Newport News can turn out – at low cost – specialized heavy equipment for process plants.

Send for *Facilities and Products* – free – today.

Newport News
Shipbuilding and Dry Dock Company
Newport News, Virginia

For more data on advertised products, use Readers' Service Cards, last page.



NOW CHASE® SELLS STAINLESS STEEL, TOO

Bars, sheets, wire, pipe and tubing now available through your Chase warehouse or sales office.

So many Chase customers use stainless steel in addition to brass and copper that we have added this metal to our regular line.

Now you can get the same top-notch Chase Service on Stainless Steel that you've been used to on other Chase products. Of course, regular delivery and cutting facilities are available on Stainless Steel orders, too.

Make Chase Your Headquarters for Stainless Steel, Too

All 24 Chase warehouses plus the Chase sales offices and Chase mills are ready to help you get prompt delivery. If your Stainless Steel order can't be filled from local stock, you'll get prompt shipment from another of the Chase warehouses or from the mill.

Chase® **BRASS & COPPER CO.**

WATERBURY 20, CONNECTICUT • SUBSIDIARY OF KENNECOTT COPPER CORPORATION

The Nation's Headquarters for Brass & Copper

Albany† Atlanta Baltimore Boston Chicago Cincinnati Cleveland Dallas Denver† Detroit Houston Indianapolis Kansas City, Mo. Los Angeles Milwaukee Minneapolis Newark New Orleans New York Philadelphia Pittsburgh Providence Rochester† St. Louis San Francisco Seattle Waterbury (†sales office only)

For more data on advertised products, use Readers' Service Cards, last page.

NEW speed...accuracy...dependability...

in the measurement of percentage hydrogen

in liquid hydrocarbons

THE NEW cenco® BETA RAY H/c METER

utilizes radioisotopes

Here is a practical, efficient precision instrument designed for use in research as well as in product control and routine analysis. It provides a fast, accurate means of measuring the percentage of hydrogen, or the hydrogen-carbon ratio, in liquid hydrocarbons.

- ★ Makes complete determination in 5 minutes
- ★ Accurate to within 0.02 weight percent hydrogen
- ★ Handles hydrocarbons ranging from normal pentane to 1.6-dimethylnaphthalene with no change in precision over the full range
- ★ Calibration is independent of pressure changes in ionization chambers since they share a common supply of gas
- ★ Temperature changes do not affect measurement since both specific gravity and beta absorption measurements are made automatically at same temperature
- ★ Twin beam instrument using single beta ray source is independent of source variations
- ★ Adequate shielding makes instrument safe from radiation hazards
- ★ Null-point balance is independent of electrometer variations

The New Cenco Beta Ray H/C Meter fills a long felt need in numerous petroleum processing operations . . . where the hydrogen-carbon ratio is altered . . . where the percentage of hydrogen is an index to the performance of end products such as jet fuels, fuel oils, gasolines, etc. Our Bulletin No. 115 contains full details about this precision instrument. Write for your copy today.

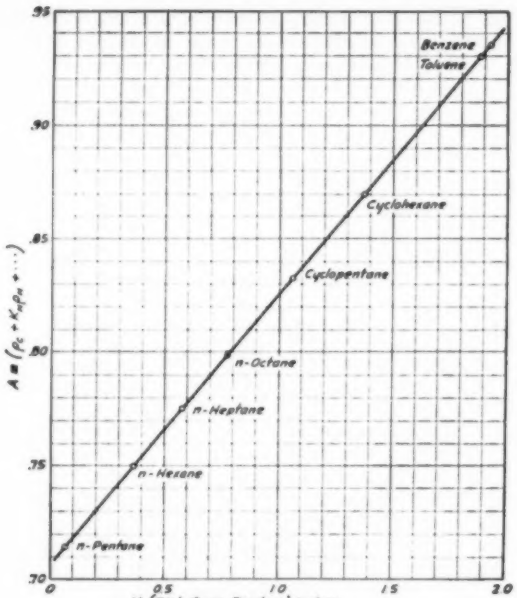


Fig 8. Typical Calibration Curve

Exclusive manufacturing and sales rights for the Cenco Beta Ray H/C Meter have been assigned to Central Scientific Company by Standard Oil Company (Indiana).

cenco

The most complete line of scientific instruments and laboratory supplies in the world

R.S.C. TULSA

CENTRAL SCIENTIFIC COMPANY

MAIN OFFICE — PLANT — CENCO INTERNATIONAL CIA.

1700 IRVING PARK ROAD • CHICAGO 13, ILLINOIS

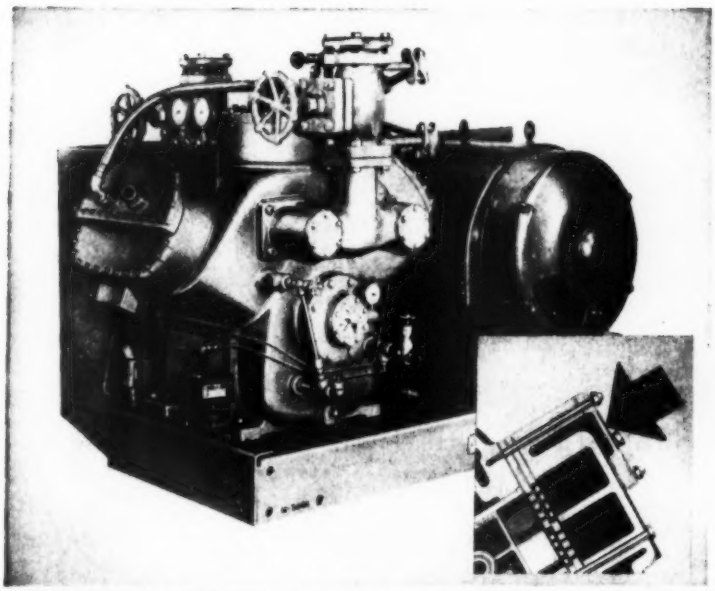
BRANCHES AND OFFICES — CHICAGO NEWARK BOSTON WASHINGTON DETROIT SAN FRANCISCO SANTA CLARA LOS ANGELES

CENTRAL SCIENTIFIC CO. OF CANADA, LTD. (and Hendry Division)

TORONTO MONTREAL VANCOUVER OTTAWA

REFINERY SUPPLY COMPANY — TULSA HOUSTON

Look at all the features of Worthington's new high-speed ammonia compressor



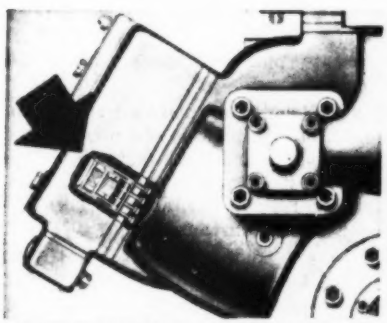
IMPROVED INTERNAL MANIFOLDING—cool suction gas completely surrounds the cylinder walls, providing longer valve life and increased overall efficiency. All passageways between suction discharge and shutoff valves are cast integrally within the crankcase, eliminating outboard fittings. Cross section shows water jacketing on one of the cylinders.

High operating efficiency and lighter weight make this modern unit the talk of the industry

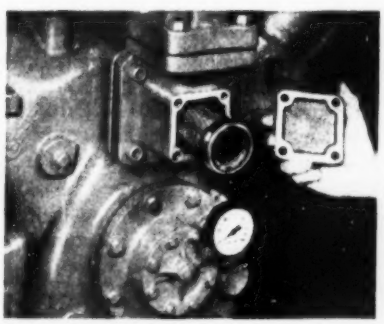
These lightweight, compact Worthington ammonia compressors have the same high operating efficiency and versatility as their lower speed counterparts.

Ranging in capacities from 18 to 150 tons, the new units can be used as high-stage or booster machines.

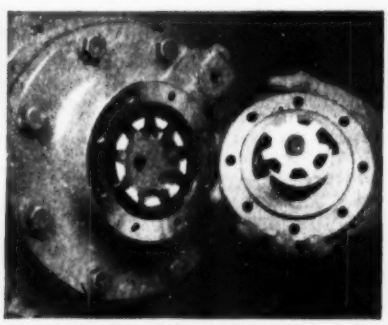
Get in touch with your nearest Worthington district office for more facts about these rugged compressors. Or write to Worthington Corporation, Air Conditioning and Refrigeration Division, Section A.3.56, Holyoke, Mass.



ELECTRIC UNLOADING—a new achievement in variable capacity control. You can start compressor with a normal torque motor; power consumption is automatically balanced against load. Separate unloader units allow easy maintenance . . . no oil or gas pressure lines to worry about.



NEW SUCTION MANIFOLD, with cover plate over suction strainer inlet, allows easy removal of the suction gas strainer for cleaning, without disturbing any of the pipes, valves or other parts. The strainer is unique in that it fits entirely within the crankcase manifold, requiring no additional space.



NEW FORCE-FEED LUBRICATION SYSTEM— full pressure, positive lubrication, regardless of rotation. A new rotary oil pump, driven directly by the crankshaft, eliminates complicated and noisy gear trains. Oil is filtered through a strainer in the crankcase for protection of pump and other moving parts.

A.3.56

WORTHINGTON

CLIMATE ENGINEERS TO INDUSTRY, BUSINESS AND THE HOME

Custom Fabrication For The Process Industries...

A BS&B-Fabricated Phenol Treating Tower goes into place in a large Gulf Coast refinery. Though not the largest made by BS&B, this vessel is fabricated of 7/8" plate, is 13' in diameter by 135' long and weighs 380,000 lbs., including trays.

Partial view of a welding bay in our Oklahoma City plant, showing pressure vessels in various stages of completion.

After fabrication is completed, the pressure vessel must be stress-relieved in this spacious bell gas-fired annealing oven. It also plays a 10-point temperature recorder with thermocouples attached directly to the vessel.

...Takes Plenty Of "Know How", "Know Why", and "Do"!

A lot of engineering talent, modern fabricating equipment, plant facilities and manufacturing skill are required to produce the kind of special equipment demanded by today's Process Industries!

Take the 2300° F. annealing oven at our Oklahoma City plant, for instance. It is among the largest of its kind to be found west of the Mississippi. In it we can stress-relieve units measuring up to 80'-0" in length, 15'-8" in diameter and weighing up to 125 tons!

We are equipped to do submerged arc (automatic), metallic arc (manual), oxyacetylene or inert-gas-shielded metal arc welding to conform to all recognized code requirements, and can fabricate plate thicknesses from 14 gauge through 4½".

Our well-equipped machine shops can fabricate both ferrous and non-ferrous alloys, solid and clad materials. The very latest in quality control, inspection and testing techniques and equipment are in constant use.

These are some of the reasons why BS&B, with its more than 60 years of service, has become known as one of the industry's leading custom fabricators of *quality* equipment. Why not take advantage of our conveniently located facilities and years of fabricating experience on your next project? Your BS&B Representative will be glad to discuss it with you in strictest confidence. Or write to...

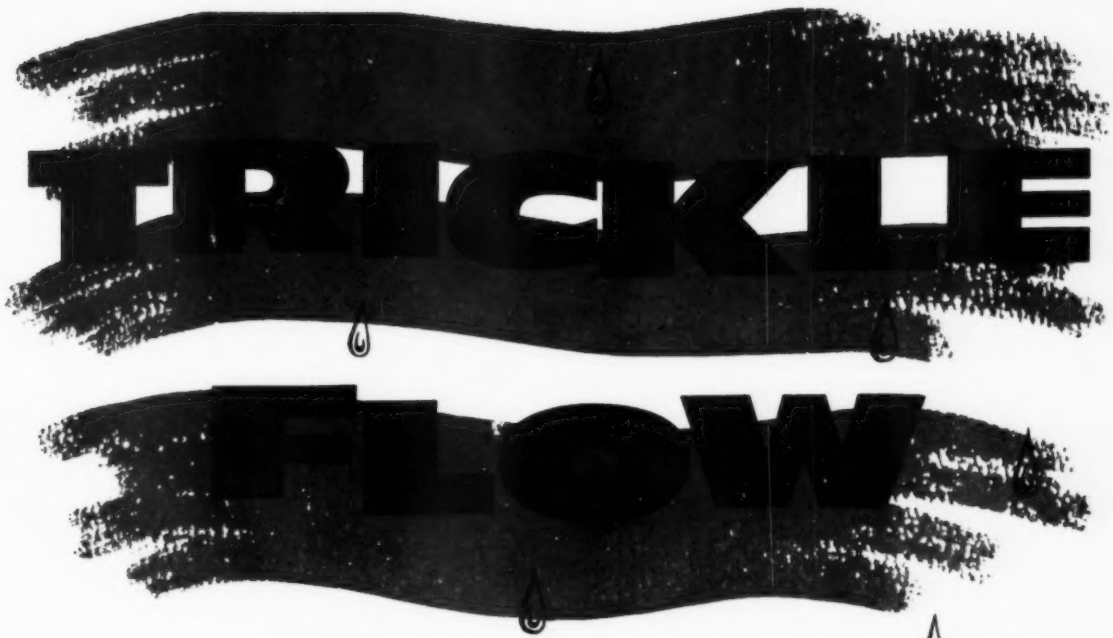
Contract Sales Division, Dept. 5-F6

EFFICIENCY OVER 60 YEARS RELIABILITY

BS&B

BLACK, SIVALLS & BRYSON, INC.

2131 So. Westwood Blvd. P. O. Box 1714 Oklahoma City, Oklahoma



the new way to remove sulfur

SHELL HYDRODESULFURIZATION PROCESS

WITH by-product catalytic reformer hydrogen available, you should look into this new Shell **Trickle Flow** Process.

Trickle Flow operation makes this process unique and economically attractive for hydrofining distillates because of:

- **Very low hydrogen recycle**
- **Sustained catalyst activity**
- **High liquid yields**
- **No need for re-running products**

The Shell **Trickle Flow** Process employs a rugged, low-cost sulf-active catalyst.

A large commercial plant, using Shell **Trickle Flow** Process, is now approaching completion and several others are being planned.

We invite your inquiries.

SHELL

SHELL DEVELOPMENT COMPANY

50 WEST 50TH STREET, NEW YORK 20, NEW YORK

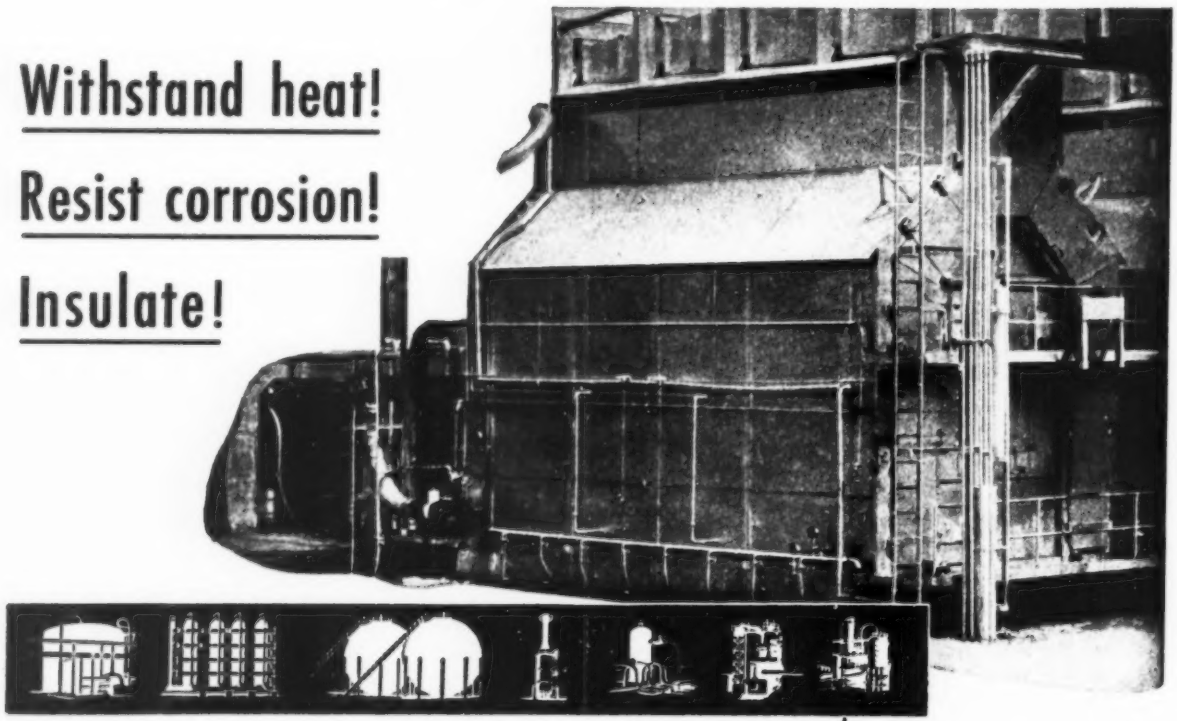
For more data on advertised products, use Readers' Service Cards, last page.

SPECIAL INDUSTRIAL CONCRETES

Withstand heat!

Resist corrosion!

Insulate!



HEATER PANELED IN CONCRETE—Low-cost, long-service construction of this 26' Universal Oil Products cracking-unit heater utilizes panels cast with economical refractory concrete—one of the special industrial concretes you can make with Lumnite Cement.

Yes—there *are* concretes that will do all three jobs, and save money at the same time! Special industrial concretes made with Lumnite* calcium-aluminate cement offer all the placing convenience of normal concrete mixtures *plus* an unusual combination of heat and corrosion resistance and insulation.

For instance, using Lumnite Cement with suitable aggregates produces concretes that withstand soaking heat or temperatures up to 2700°F. Provides high insulating efficiency, too, if needed. And the chemical composition of Lumnite Cement makes all these concretes highly resistant to the attack of sour crude and sulphur vapors.

Performance like this means that you can save throughout the refinery with fast, economical concrete construction. Down time is cut to a minimum, because special industrial concretes are quickly placed by cement "gun," trowel or pouring. And they reach service strength in 24 hours or less!

For convenience you may prefer to make these special industrial concretes with prepared castables (Lumnite Cement plus aggregates selected for specific temperature and insulation service—add only water.) They're made by refractory manufacturers and sold through their dealers. For more information write Universal Atlas Cement Company (United States Steel Corporation Subsidiary), 100 Park Avenue, New York 17, N.Y.

WHERE TO USE SPECIAL INDUSTRIAL CONCRETES:

- **Tank linings and pipe linings for protection from sour crude.**
- **Linings in regenerators; fractionating columns; cracking, vacuum distillation, and alkylation units; stripper and flash towers; accumulators and soakers.**
- **In heaters, furnaces and coking ovens.**
- **Stack and flue linings.**
- **In ducts and furnace foundations.**

**"LUMNITE" is the registered trade-mark of the calcium-aluminate cement manufactured by Universal Atlas Cement Company.*

PR-L-79RR

ATLAS **LUMNITE for INDUSTRIAL CONCRETES**

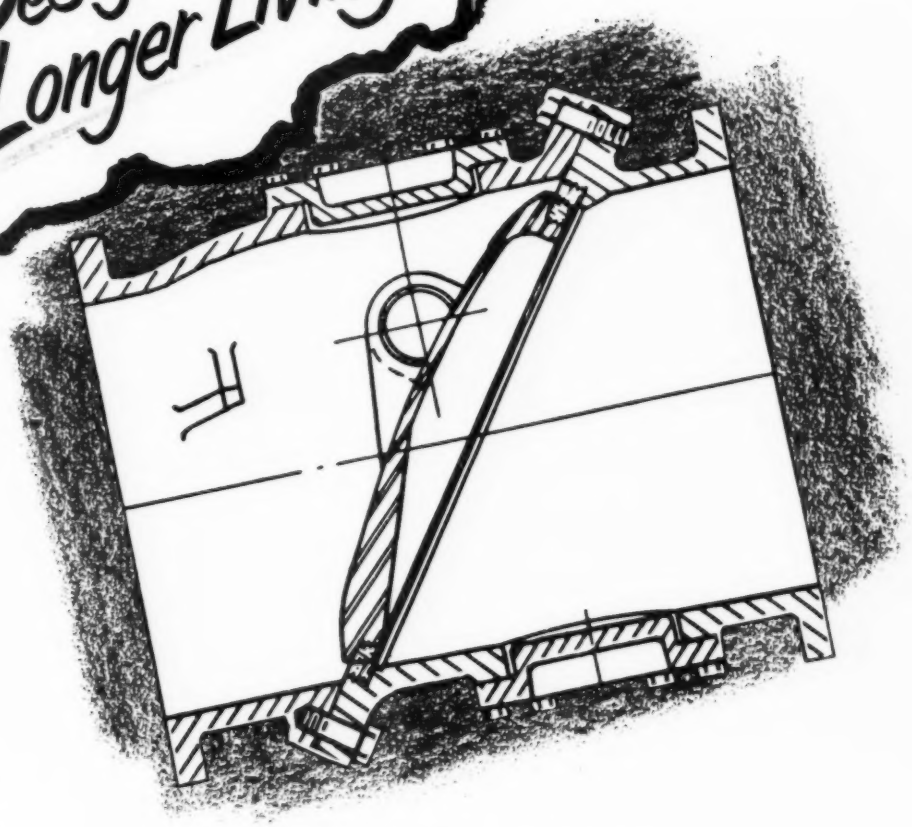
REFRACTORY, INSULATING, OVERNIGHT, CORROSION-RESISTANT

A UNIVERSAL ATLAS PRODUCT

UNITED STATES STEEL HOUR—Televised alternate weeks—See your newspaper for time and station

For more data on advertised products, use Readers' Service Cards, last page.

Design for Longer Living



...You find it only in

CHAPMAN'S

Tilting Disc CHECK VALVE

Here you can see the specially designed *airfoil section* of the disc in the Chapman Tilting Disc Check Valve . . . and you can see how the disc-seat lifts away from the body seat when opening (and drops into contact when closing) with no *sliding or wearing of the seats.*

Under usual piping arrangements this unique designed disc won't slam . . . just cushions itself to a quiet closing that does not even jar the line.

And this balancing is the reason why Chapman Tilting Disc Check Valves greatly reduce head-loss over standard designed swing-type checks . . . as proven by tests in leading engineering schools and by actual performance in the field.

Available in iron or steel. Complete test data is given in Catalog No. 30–write for your copy now.

The Chapman Valve Mfg. Co.
INDIAN ORCHARD, MASSACHUSETTS

For more data on advertised products, use Readers' Service Cards, last page.

how much can ALCOA

from well to user, Alcoa Aluminum saves money for oil and gas men

ALCOA ALUMINUM INDUSTRIAL BUILDING SHEET has become the favorite lightweight metal for roofing and siding that will stand up in corrosive atmospheres with a minimum of maintenance required.

ALCOA ALUMINUM TREAD PLATE, CONDUIT AND HANDRAILS are also available for use wherever corrosion is a problem.

ALUMINUM PAINT, made of ALCOA Pigments, covers better, lasts longer, costs no more than ordinary paints. That, plus excellent reflective qualities, has made it the most practical, most popular paint in the petroleum industry.

ALCOA ALUMINUM PIPE is particularly economical for construction across rivers, swamps and hilly terrains because aluminum is so light, so easy to handle. Two men can easily handle 40-ft lengths of 8⅝-in. OD pipe.

ALCOA ALUMINUM SHEET is used to weatherproof thermal insulation.

ALCOA ALUMINUM INSTRUMENT TUBING—hundreds of miles of it—are in use throughout the petroleum industry. ALCOA Utilitube® comes in lengths up to 1,000 feet and more . . . costs 40 per cent less than tube made of other corrosion-resistant metals.

FREE — new booklet, *Alcoa Aluminum Heat Exchanger Tubes.* Write for your copy today.

For more data on advertised products, use Readers' Service Cards, last page.

ALUMINUM save you?

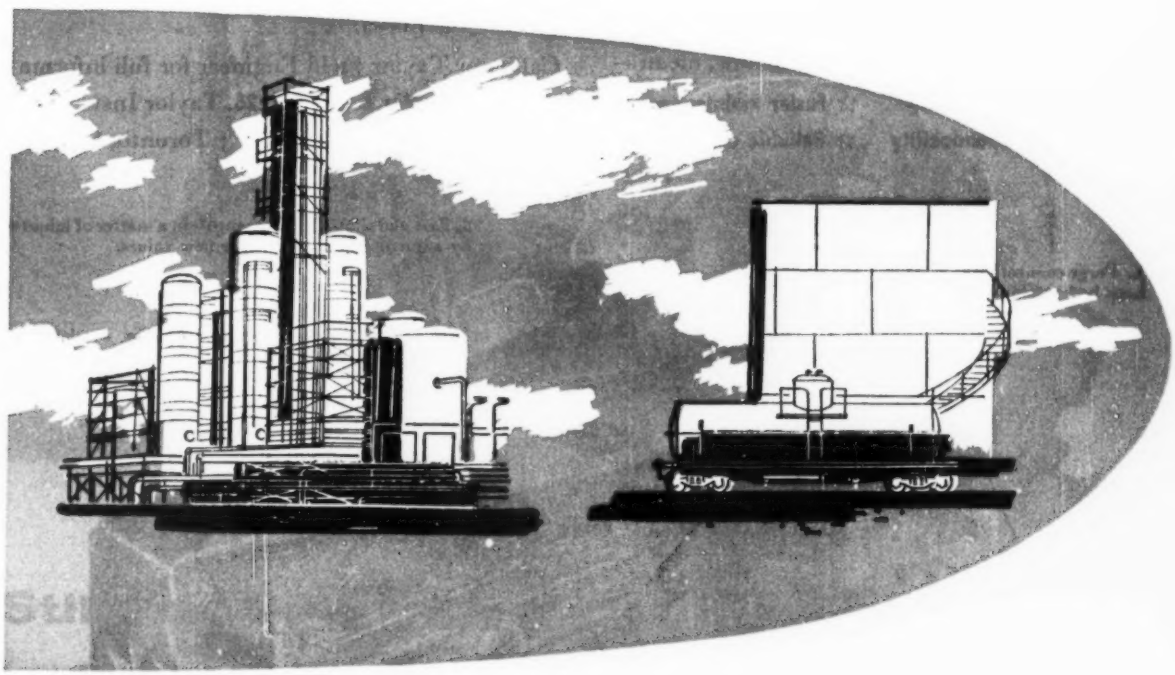
Alcoa Aluminum offers real money savings to the petroleum industry.

It's lower in original cost than other corrosion-resistant metals.

It has excellent low-temperature properties.

It resists corrosion. It's easily worked.

Write today for all the facts.



ALCOA ALUMINUM HEAT EXCHANGER TUBES have been used for more than 20 years, handling sour gasoline stocks. Because ALCOA Aluminum is resistant to hydrogen sulfide, ammonia, carbon dioxide, hydrocarbons and cooling waters, it is ideal for catalytic cracking overhead condensers, compressor intercoolers and aftercoolers.

ALUMINUM BUBBLE CAPS have given service of 10 to 15 years in debutanizer columns, handling gasoline distillate from sour crudes at 200° to 425° F as well as in fractionating columns for sour crude gas oils at 400° to 625° F.

ALUMINUM FORMS FOR MOLTEN SULFUR are used since ALCOA Aluminum has exceptional resistance to sulfur fumes and gaseous compounds.

ALUMINUM TANK CARS, used for more than 25 years to transport sensitive products, cost up to ⅓ less than stainless steel cars.

ALUMINUM STORAGE TANK ROOFS for sour crude oils have been in service for more than 22 years in locations where steel roofs failed in less than five years. Internal supporting structure, hatches, vent lines and other fittings are of ALCOA Aluminum.

ALCOA ALUMINUM

ALUMINUM COMPANY OF AMERICA

905-F Alcoa Building, Pittsburgh 19, Pa.

For more data on advertised products, use Readers' Service Cards, last page.

Taylor Flow Transmitter gives you MANY OUTSTANDING ADVANTAGES

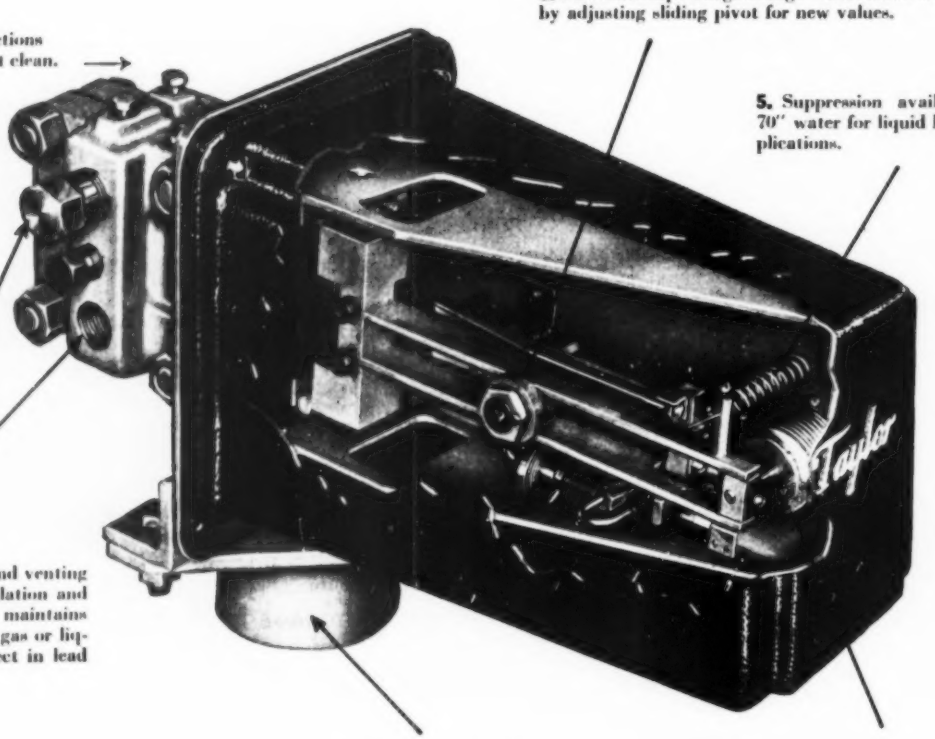
THE Taylor TRANSAIRE* Differential Pressure Transmitter gives you many very desirable features, in addition to the inherent advantages of a force-balance instrument such as: mercuryless; simplified installation and piping; seal pot elimination; lightweight, etc. These extra features, indicated on the picture below, mean—

- ☆ **Increased flexibility**
- ☆ **Easier maintenance**
- ☆ **Rugged dependability**
- ☆ **Reliable accuracy**

About half of your instrument problems are connected with flow. Here is an instrument that will solve them—and many others requiring differential pressure measurement and transmission.

♦ ♦ ♦

Call your Taylor Field Engineer for full information, or write for **Bulletin 98226.** Taylor Instrument Companies, Rochester, N.Y.; Toronto, Canada.



1. Purge connections keep body swept clean.

2. Self draining and venting—simplifies installation and maintenance and maintains accuracy because gas or liquid will not collect in lead lines.

3. Easy mounting—top, side or bottom.

4. Self contained linear dampener. No mess, no fuss; factory filled.

5. Suppression available to 70" water for liquid level applications.

6. Fast and simple range change—in a matter of minutes by adjusting sliding pivot for new values.

Taylor Instruments MEAN ACCURACY FIRST

Still 'tops' in Catalyst Recovery

Multi-stage Buell Collector for catalyst recovery engineered to eliminate the need for supplementary collection equipment.

For both fluid and thermofor catalytic cracking Buell high-efficiency cyclones continue to function successfully in separating catalyst materials from the vapor stream. All major oil refineries are included in Buell's customer list. For complete information on all types of dust collection and recovery write: Buell Engineering Company, Dept. 21-F, 70 Pine Street, New York 5, N. Y.

buell®

MECHANICAL ELECTRICAL

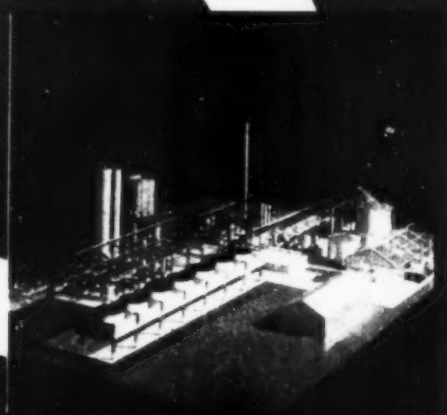
20 Years of Engineered Efficiency in
CATALYST RECOVERY

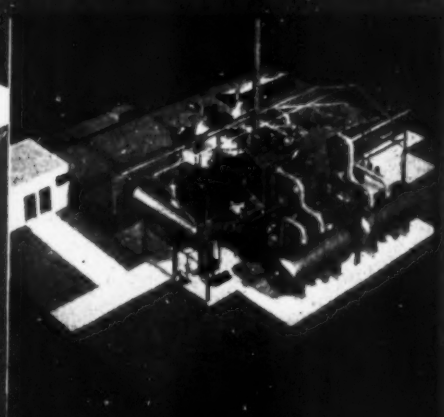
For more data on advertised products, use Readers' Service Cards, last page.

natural gas and sulfur...

PARSONS

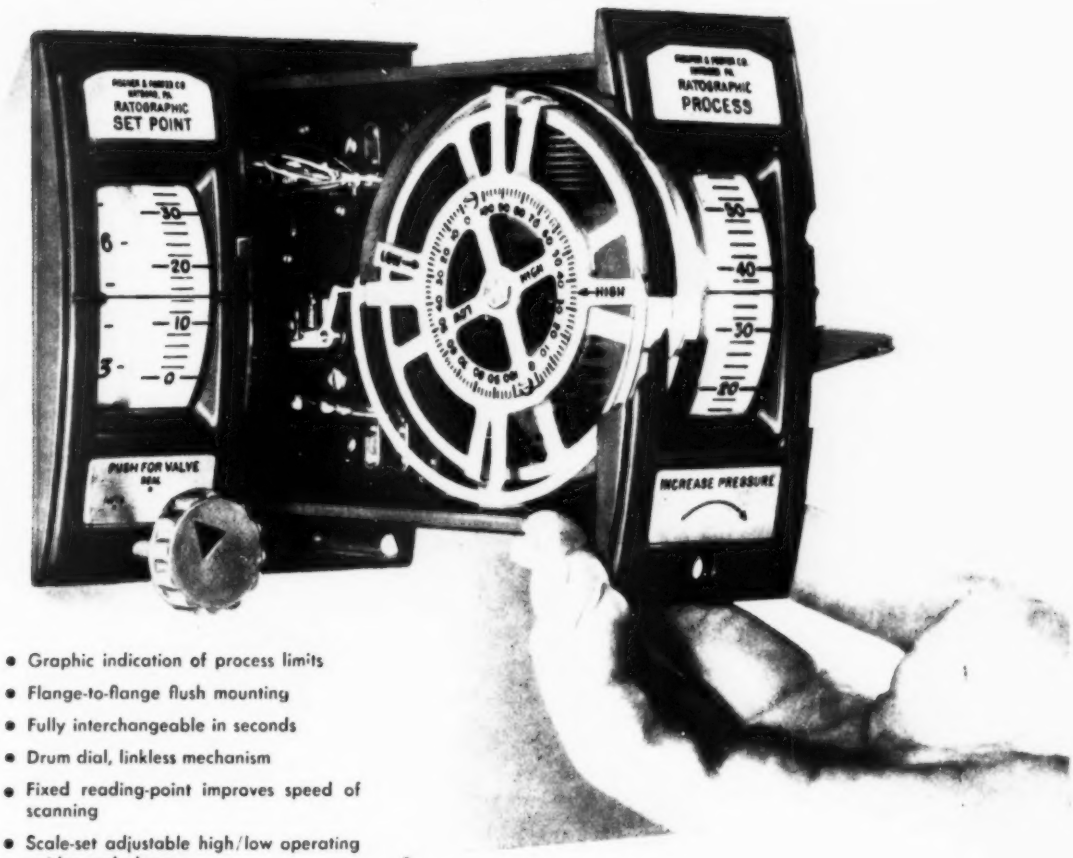
THE RALPH M. PARSONS COMPANY





NEW

Ratographic* miniature indicators



- Graphic indication of process limits
- Flange-to-flange flush mounting
- Fully interchangeable in seconds
- Drum dial, linkless mechanism
- Fixed reading-point improves speed of scanning
- Scale-set adjustable high/low operating guides and alarms
- Plug-in unit easily removed with finger jack for check or change

Completely described and illustrated in Catalog 55-10. Write for it today.

Fits panel space only 2⅜" x 5⅜" yet with 5¾" long, readable scale in keeping with ½% accuracy.
Unique, new "graphic guides" mark high/low operating range, are adjustably mounted on scale drum and carry switch trippers to actuate alarms or take emergency action. Rotating drum dial and fixed reading point permit large, easily read figures and open, uniform scale. Building block construction of Ratographic indicators permits field addition of alarms and guides to the basic precision pneumatic indicator. Illustrated are two indicators which form a control selector station accessory for remotely mounted controllers.

complete process instrumentation

FISCHER & PORTER CO.

*T.M., F&P Co.

2340 County Line Road, Hatboro, Penn.

Company owned sales and service branches strategically located throughout the world.

Two Terry Turbines equipped with "trouble eliminators"

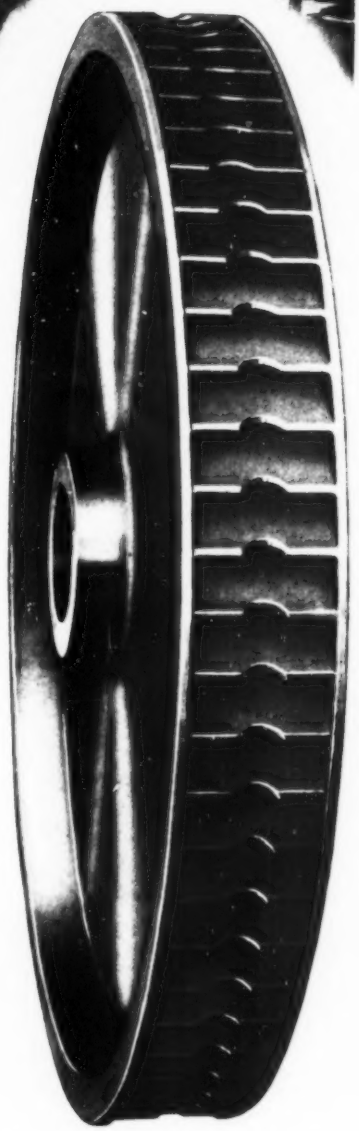
Because these turbines have solid wheels, they can take a lot of abuse, without complaint. Here's why:

1. The wheel has no separate parts to become loose or work out. It is a single forging, in which a series of semi-circular buckets is milled.

2. Blade wear is of little consequence because the power-producing action of the steam takes place on the curved surfaces at the back of the buckets. Wear does not materially affect horsepower or efficiency.

3. The blades cannot foul. There is a one inch clearance on either side of the wheel and, in addition, the blades are double rim protected. There is no need for close axial blade clearance, because the steam enters the buckets in a direction at right angles to the shaft.

For complete details of these *work horses of industry*, send for a copy of bulletin S-116. No cost or obligation.



THE TERRY STEAM TURBINE CO.

TERRY SQUARE, HARTFORD 1, CONN.

TERRY

TT-1199

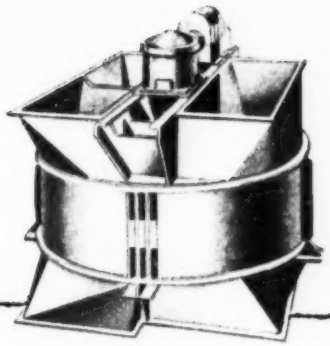
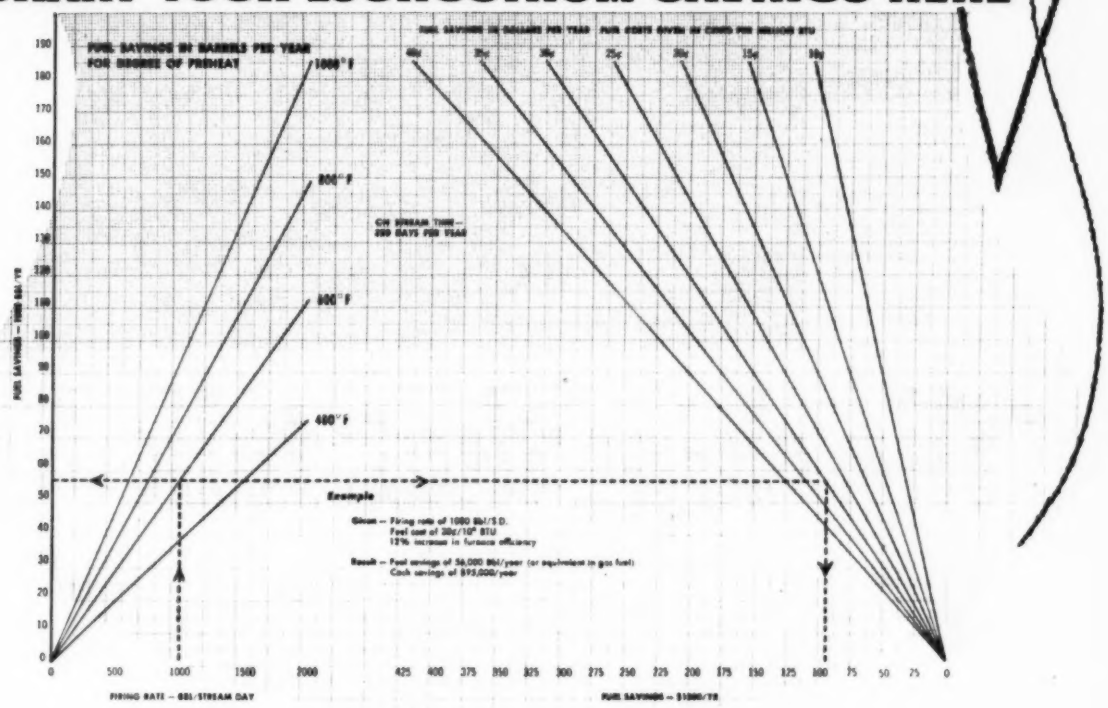


CHART YOUR LJUNGSTROM SAVINGS HERE



Start at the firing rate in your process units . . . allow a reasonable amount of air preheat (the higher the preheat, the more you'll save) . . . and look to the left for fuel savings. To convert that figure to cash — move to the right to your fuel cost line, and check your savings directly below.

The savings you'll discover for yourself are not fantasy, either. They simply prove why a Ljungstrom Air Preheater will pay for itself in eighteen months . . . a year . . . even nine months or less —in fuel savings alone!

And that isn't all. When you add to this the increased production . . . higher product quality . . . decreased furnace maintenance typical of operations including a Ljungstrom — you'll see why the Ljungstrom Air Preheater can be the oustanding factor in your refinery for *top economy and throughput*. Write today for full details.

The Air Preheater Corporation 60 East 42nd Street, New York 17, N. Y.

For more data on advertised products, use Readers' Service Cards, last page.

The chips that talk...

To the native savage, whose tribe had no conception of a written language, the piece of wood on which the explorer scribbled a message became the wonderful "chip that talks."

The chips of metal that pour in silver drifts from the mighty machines in Sun Ship's Wetherill plant tell their stories, too. Those shown on the 14-foot boring mill tell part of the story of a fast, thorough repair job on ship-propulsion machinery. That job required lifting a 54-ton section of crankshaft from the ship to a 10 ft. x 50 ft. engine lathe, where it was checked for trueness and the journals machined. The crankpins were machined in a huge crankshaft machine. The boring mill operation shown was the facing of the webs of a new section which replaced one of the damaged sections of the crankshaft.

That's the kind of story the versatile men and machines at Sun Ship have been writing for decades . . . in building special machinery of every type for the varied industries that are building a greater America.

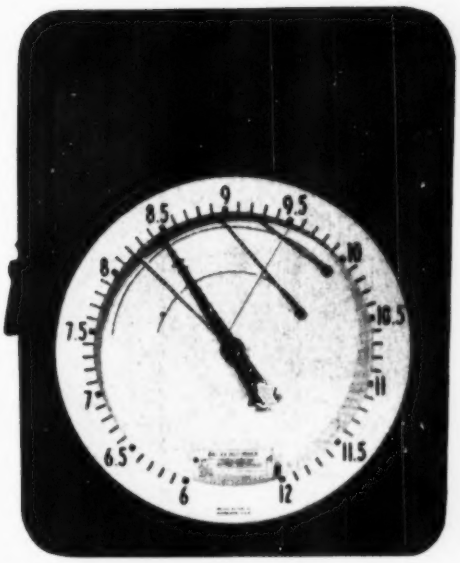
Sun

SHIPBUILDING & DRY DOCK COMPANY

ON THE DELAWARE (SINCE 1916) **CHESTER, PA.**

25 BROADWAY • NEW YORK CITY

PYROTRON
by BAILEY...



Your best buy for Precision Temperature Measurements In the -300F to 1200F Range

Check These Exclusive Bailey Advantages of Resistance Thermometer Operation

✓ Resistance thermometer operation over a complete range from —300F to 1200F has been made possible by Bailey's development of a low-cost platinum resistance element.

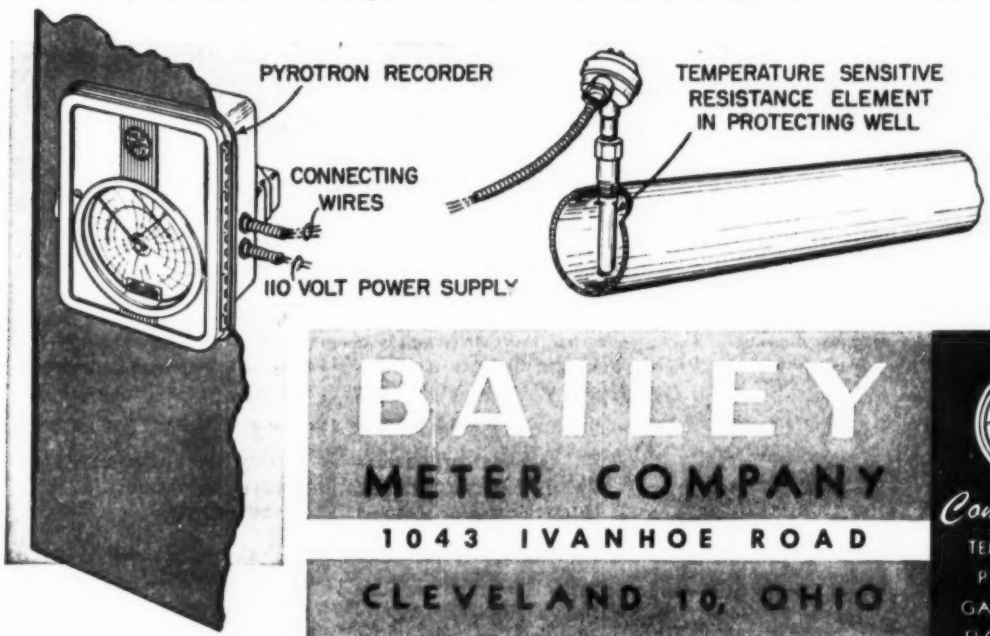
✓ Resistance thermometer operation requires no standard cell, dry battery and cold junction compensator. Uses 115 volt a-c source. Strong signal and high precision of resistance element as compared to thermocouple makes possible the use of narrow range spans.

✓ The Bailey Pyrotron is calibrated at the factory and *remains* accurate; no periodic re-calibrations required. Since all elements are matched it is not necessary to calibrate each recorder to its element.

✓ Recorder is sensitive to 1/10 of 1% of range span.

✓ Ordinary copper lead wires permit remote location of recorder with respect to the temperature sensing element.

✓ For complete information, write for bulletin 230-C on the Bailey Pyrotron Electronic Resistance Thermometer. P-27-1

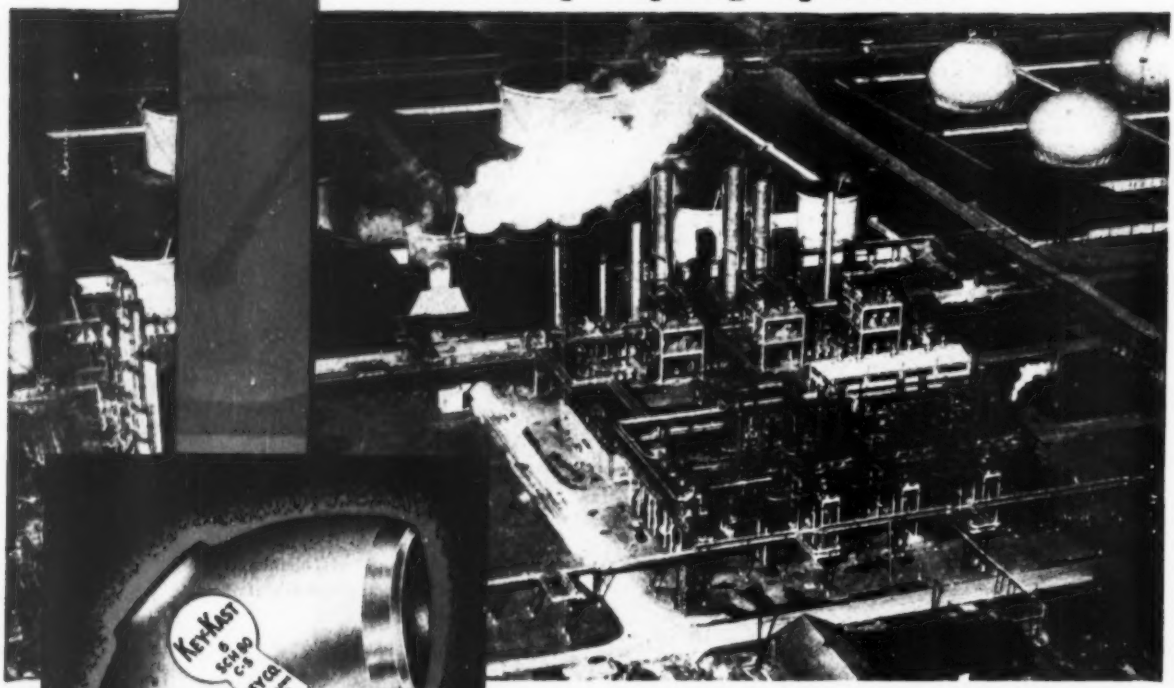


BAILEY METER COMPANY
1043 IVANHOE ROAD
CLEVELAND 10, OHIO
Complete Controls for Process Plants

BAILEY METERS
Controls for
TEMPERATURE
PRESSURE
GAS ANALYSIS
FLOW LEVEL
RATIO

For more data on advertised products, use Readers' Service Cards, last page.

Higher Strength at Lower Cost for Alloy Piping Systems



KEY-KAST
WELDING FITTINGS

KEY-KAST FITTINGS OFFER

- Greater wall thickness throughout—for increased structural strength
- Extra thickness in critical cross-ring for greater allowance against erosion
- Lower cost
- Materials that meet A.S.-A.I. and A.S.A. Codes
- Rigid testing and inspection to meet high standards of quality

Serve NEW SUNOCO Marcus Hook Refinery

This well-ordered maze of steel piping and fractionating towers is Sun Oil Company's new petrochemical plant, located at the 1,900-acre Sunoco refinery at Marcus Hook, Pennsylvania. It produces aromatic chemicals for the synthetic rubber, plastic, detergent and other industries.

As added insurance against breakdown in the flow of these vital materials, Sun Oil Company chose sturdy, dependable KEY-KAST Welding Fittings to serve the piping system in this ultra-modern $15,000,000 plant.

WRITE TODAY for new Bulletin

KEY-KAST FITTINGS ARE AVAILABLE IN EVERY SHAPE, SIZE, AND SCHEDULE

IN LOW AND INTERMEDIATE ALLOYS AND VARIOUS STAINLESS STEELS

Since 1916 . . . manufacturers and developers of products for high temperatures and pressures

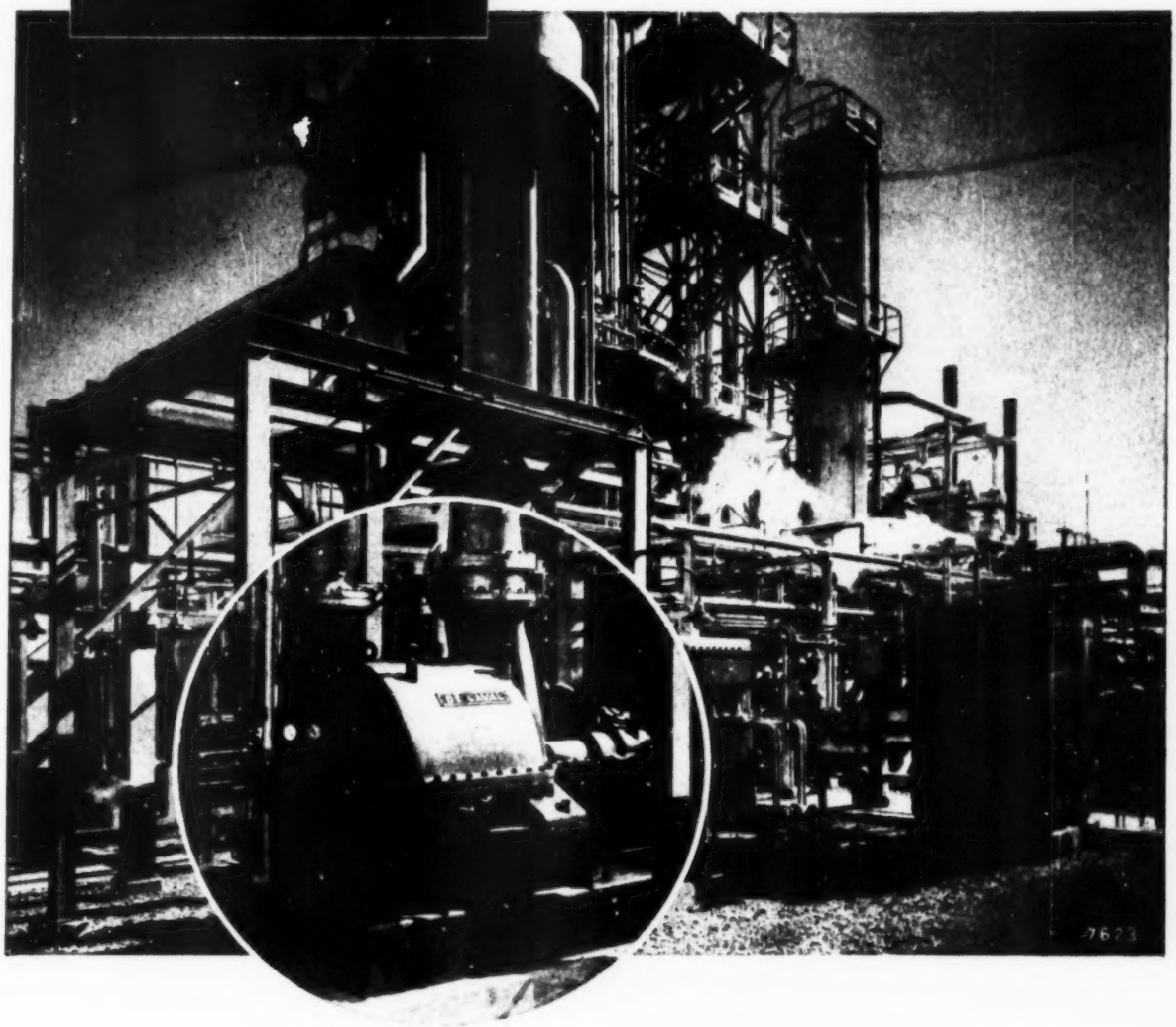
key company

Box 494-E, EAST ST. LOUIS, ILLINOIS

DISTRICT OFFICES: NEW YORK • CLEVELAND
CHICAGO • TULSA • HOUSTON • LOS ANGELES

DE LAVAL CENTRIFUGAL BLOWER

delivers 17,400 cfm for Elreco's new cat



This De Laval Centrifugal Blower, on stream at the El Dorado Refining Company's new cat cracker at El Dorado, Kansas, supplies 17,400 cubic feet of air per minute for regeneration of the spent catalyst.

This plant, built in record time of ten months by The Refinery Engineering Company, is designed for a charge capacity of 4,300 barrels per day at 75% conversion. Elreco is another of many refineries which have chosen De Laval for dependable blower performance under heavy-duty, continuous operation. Rugged castings, husky, perfectly balanced rotor and externally mounted, cylindrically seated bearings are design features that reduce maintenance and insure long service. Send for Bulletin 0500 containing complete data.

DE LAVAL *Centrifugal Blowers*

DE LAVAL STEAM TURBINE COMPANY

811 Nottingham Way, Trenton 2, New Jersey

OL 207

For more data on advertised products, use Readers' Service Cards, last page.

Another reason why OHMSTEDE can save you money in Retubing. . . .

The above drawing illustrates the OHMSTEDE method of removing the floating tube sheet. This special machine (patented and manufactured by Ohmstede) saves many hours on every retubing job and results in savings to you.

Reasons why you should send us your Heat Exchangers for Retubing. .

- ✓ WE SPECIALIZE IN RETUBING.
- ✓ COMPLETE STOCK OF CONDENSER TUBES.
- ✓ LATEST TYPE OF EQUIPMENT.
- ✓ PICK-UP AND DELIVERY SERVICE.
- ✓ LOWER COST TO YOU.
- ✓ FAST AND EFFICIENT SERVICE.
- ✓ IMMEDIATE QUOTATIONS BY TELEPHONE.
- ✓ 24 HOUR SERVICE.

THE WORLD'S FIRST HYDRO-BLAST TUBE BUNDLE SERVICE . . .

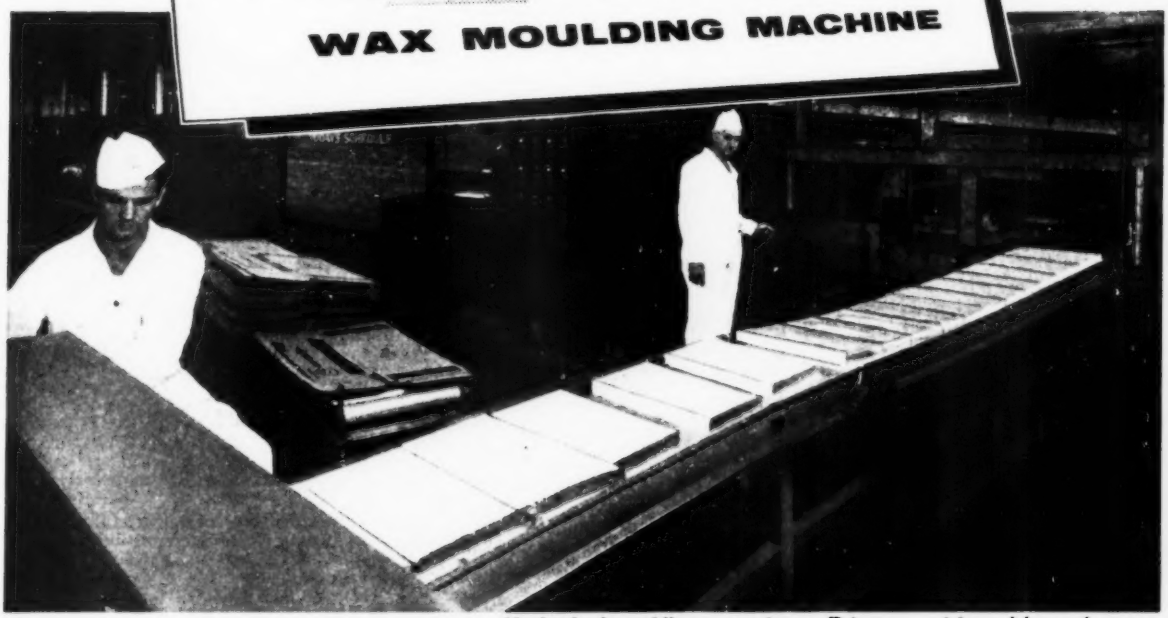
For greater exchanger unit efficiency, use OHMSTEDE'S Hydro-Blast service . . . A new and more efficient method of cleaning Heat Exchangers. It effects significant savings in cleaning time. It does a thorough cleaning job. It materially promotes operating efficiency. OHMSTEDE picks-up and delivers.

FOR SERVICE CALL— OHMSTEDE MACHINE WORKS

ESTABLISHED 1905

TELEPHONE 4-6376 • P. O. BOX 1288 BEAUMONT, TEXAS

THE GREER CONTINUOUS WAX MOULDING MACHINE



Mechanized moulding — maximum efficiency — minimum labor and space.

What is it costing you to be without one?

Labor **A Greer Wax Moulder** increases pounds of wax slabbed per manhour 3½ to 5 times over conventional batch processes. It automatically deposits, cools, and demoulds up to 15,000 pounds per hour of 10-lb. cakes.

Floor Space . . . more valuable than ever, and **a Greer Wax Moulder** uses only approximately 1/10th that occupied by usual batch processes of equal capacity.

Product Uniformity and Appearance

Cakes are held within ½ of 1% in weight for a given setting by the volumetric depositor in **a Greer Wax Moulding Machine.** You'll get improved appearance and cleanliness of cakes, too.

Compare these profit-building advantages with your present wax-slabbing process, then get all the facts on the Greer Wax Moulding Machine. There is no obligation

J. W. GREER COMPANY

WILMINGTON, MASSACHUSETTS

Sales Engineering Offices: New York, N. Y., Chicago, Ill., San Francisco, Calif.

GREER

For more data on advertised products, use Readers' Service Cards, last page.

CATFORMING *means*

SIMPLICITY

for high octanes and high yields at low cost

Simplicity is the keystone of Catforming. Why? Because simplicity takes the high cost out of high octanes and high yields.

Simplicity speeds construction of Atlantic Catforming units—saving you money and time.

Simplicity makes operation of these units easy—saving you money on operating costs and manpower as well.

Simplicity means efficiency — Catforming cuts out intermediate steps in processing feed stocks, gives you high octane gasoline ready for immediate blending—and distribution.

Simplicity goes all the way with Catforming, including the licensing agreement—you'll find it well worth looking into. Remember, the performance of Catforming units has been proved in highly successful commercial operations in many areas. Write, wire or phone for detailed information — ask for our brochure, "CATFORMING." The Atlantic Refining Company, Research and Development Dept., P. O. Box 8138, Philadelphia 1, Pa.

ATLANTIC *It's the Catalyst that counts*

The Mail Box . . .

Argentine Ideas

To The Editor:

The January issue of the PETROLEUM REFINER is a very good one and your staff is to be congratulated on it. The boys from the Mechanical department and of the Metal Inspection group are very interested in all the articles of the Maintenance Special Issue and particularly, in your nationwide survey on inspection practices and problems. Incidentally, it might interest you to know that practically all the conclusions derived from that survey are valid for our refinery here in Argentina.

You mention that plans for other special issues for 1954 are under way. I wonder if PETROLEUM REFINER readers in U. S. A. would be interested in several subjects which in our refinery are candent day-to-day problems and of which very little or practically no literature is available. These include: Cost Control Practices, Operating Standards (Make-Up and Follow-Up), Plant Yields, and Fuel Oil and Utility Control Practices.

Another interesting subject and worthy of consideration would be a survey on Refinery Organization Trends, showing management's up-to-date point of view regarding the best organization to improve manpower utilization, both labor and technical.

J. A. Yanes
Chief, Process Tech Service
Campana Refinery-Esso Refinadora
Argentina

'Best Work Published'

To The Editor:

I have read with great interest the papers on "Dimensional Analysis" (by L. H. Silberberg and J. J. McKetta) published in the 1953 issues of PETROLEUM REFINER. It is probably the best work on the subject so far published. Unfortunately, our departmental library does not subscribe for PETROLEUM REFINER and therefore may I venture to request by airmail the full set of reprints of papers on the subject? Necessary charges will be borne by me.

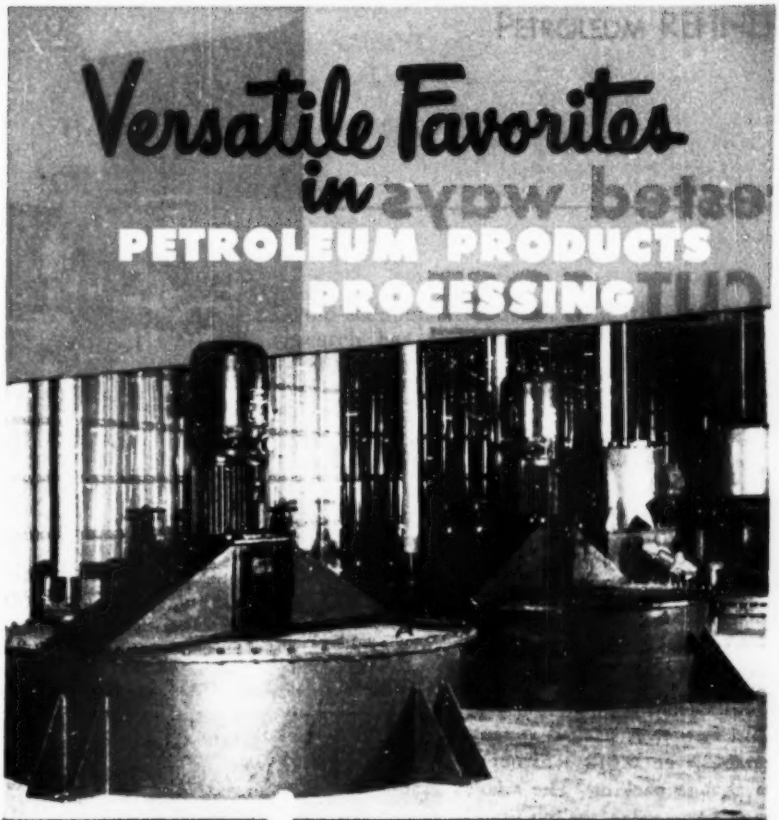
Dr. S. M. Shah,
Reader in Chemical Engineering,
Department of Chemical Technology,
University of Bombay,
Matunga, Bombay 19 (India)

'Never More Response'

To The Editor:

I have never had more response through the mail on any article previously written for magazines than on the one on management development which appeared in your previous issues. Standard of New Jersey asked for six tear copies and other companies have written requesting further information along certain areas which I discussed. I thought you might be interested, since it is an indication that the readers are reading the articles along this nature which you are publishing.

David F. Tver, Director,
Industrial Relations,
Anderson-Prichard Oil Corp.
Oklahoma City.



PATTERSON
SATISFACTORY
Kettles

Patterson Grease Kettles are supplied in a wide range of sizes for every petroleum processing need —single or double motion drives— any desired internal or jacket pressure. Let us consult on your needs!

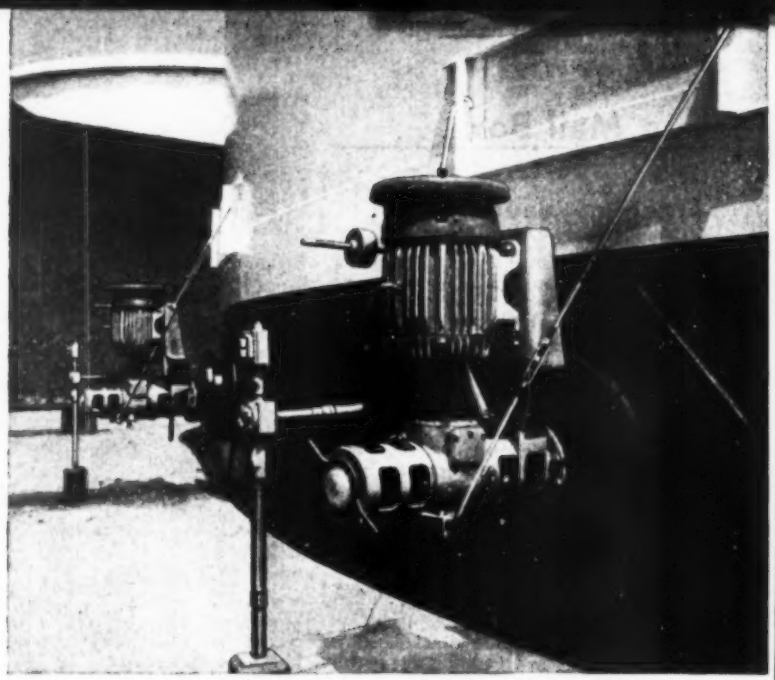
Richard L. Carney

The Patterson Foundry and Machine Company
East Liverpool, Ohio, U. S. A.
NEW YORK, BOSTON, BALTIMORE, PHILADELPHIA, PITTSBURGH, DETROIT, CINCINNATI, ATLANTA, CHICAGO, ST. LOUIS, HOUSTON, DENVER, LOS ANGELES, SAN FRANCISCO, SEATTLE
The Patterson Foundry and Machine Company, (Canada) Limited
Toronto, Canada
MONTREAL

For more data on advertised products, use Readers' Service Cards, last page.

2 tested ways to CUT COST

of mixing and blending in big tanks



YOU CAN REPACK the stuffing box or replace the rotary mechanical shaft seal on a LIGHTNIN Side Entering Mixer, under a full head of 5 million gallons—without losing a pint of product.

Now you can *choose* the kind of mixer shaft sealing that best meets your operating requirements—gives you the most in trouble-free operating hours . . . in maintenance dollars saved.

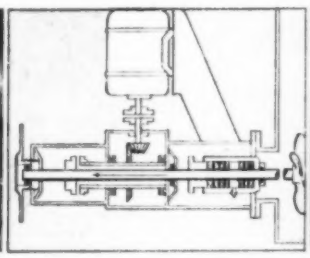
1. You get easier repacking than ever with the standard LIGHTNIN packed stuffing box. You need never take the tank out of service to change packing. The mixer shaft retracts like a valve, sealing liquid in the tank, so you can repack in a jiffy and resume operation.

2. You eliminate repacking—for good— with the new LIGHTNIN rotary shaft seal! This seal runs without adjustment for its entire lifetime. When it finally wears out, you can replace it in a few minutes—by changing one simple cartridge component!

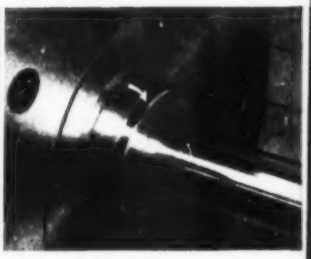
These are *two* good reasons why it pays to specify LIGHTNINS for blending, treating, TEL addition, bottom sediment control in crude storage tanks, and other big mixing operations.

For quick, competent help—and fully guaranteed results—on *any* fluid mixing job, big or small—call in your LIGHTNIN representative. Or write us today.

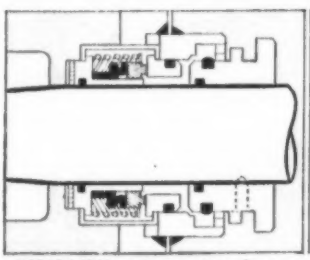
STUFFING BOX repacking is fast, simple. Turning this easy-to-get-at bearing member...



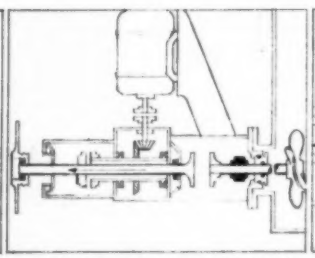
...retracts the mixer shaft outward, like the stem of a valve. Inside the tank...



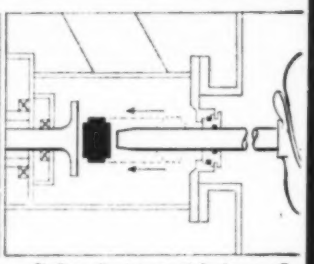
...a Teflon "O" Ring squeezes against the shaft and flange hub, keeping product safely in the tank while you change packing.



ROTARY SEAL ends repacking—forever. Seal runs without adjustment for its lifetime. Easy to replace, too...



...Shaft comes apart. Tank end of shaft locks in place and seals liquid safely in the tank...



...Shaft coupling is removed. Seal comes off as a unit. New seal goes on as a unit. In a few minutes, you're back in operation.

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The LOOK BOX for June . . .

What Now, Management?

"I WAS VERY much impressed with your article, 'What Now, Industrial Relations?' which was published in the March issue of PETROLEUM REFINER.

"I would like to disseminate your thinking among my men who are responsible for our employe-management relations . . ."

This excerpt from a letter by W. R. Argyle of Sinclair Refining Company to Author Wm. S. Wilcox typifies the interest of petroleum executives in any sound discussion of one of the greatest dilemmas facing our industry today. On every hand are evidences of management's earnest desire to give employes the highest wages, the best working conditions—and yet there is a powerful new move to organize the biggest oil union in history.

In the words of John G. Pew, vice president of Sun Oil Company, the situation calls for a "fresh appraisal of the subject of labor-management relations."

Pew cited the U. S. Bureau of Labor Statistics in asserting that "the average weekly earnings for refinery workers were $93.30 in 1953 as compared with $71.57 for the average manufacturing worker."

He challenged management to seek an "explanation as to why, in the face of high wages, steady employment, and favorable benefits, some employes might wish to see a change in collective bargaining arrangements in this industry."

Research In Planning

NO ENGINEER need be sold on research, but some companies have been reticent to advance research directors to positions of over-all company responsibility. Due to the tremendous advances made in physical and chemical research, this picture is rapidly changing and we now find many companies with people of research background in the top spots. But the advances in research have had even a greater impact on company growth—research is now moving horizontally into other fields.

Applied research must be compatible with a company's financial capabilities, market conditions and techno-economic trends. It is in these fields that research has now moved to put company planning on a scientific basis.

As Dr. J. E. Hobson, director of Stanford Research Institute said recently, "The increasing use of scientific techniques for comprehensive company planning introduces a new dimension of competition into an increasingly competitive atmosphere. It may be introducing a business atmosphere in which management mistakes become more costly because fewer such mistakes can or will be made."

Low Demand Affects Picture

LITTLE IMPROVEMENT in the industry's economic position was made in the past month as demand for its products continued to run below expectations. Despite holding refinery runs to stills to last year's level, gasoline output was higher than it had been in the corresponding period of 1953. Consequently, stocks of motor fuel remained on the too-high side.

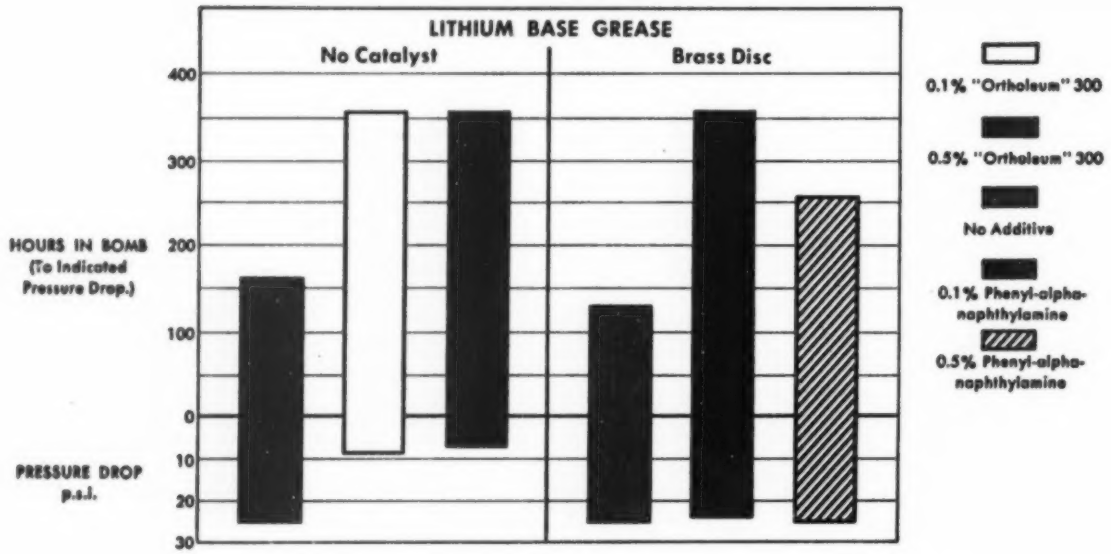
Unless there occurs a sudden spurt in consumption, a prolonged period of relatively low refinery activity will be necessary to bring inventories into balance with requirements.

Refinery operations have been cut-back, but still gasoline inventories have got out of hand. The reason is quite simple. Despite lower refinery output, gasoline production has been increased. An average of 3,400,800 barrels of gasoline have been manufactured per day during the first 20 weeks of 1954, almost 100,000 barrels a day more than was made in 1953.

Of course, the refining reduction has made it possible to keep product inventories, except gasoline, from mounting to burdensome levels. However, refiners' yields have resulted in too much gasoline. Refinery improvements have been made in many instances for this increased gasoline yield from crude. This progress which enables refiners to better their outputs may do much harm to the economic position of the industry's big money product—gasoline.

Very important to the whole picture has been the failure of demand to live up to expectations. During the first four months of 1954, total requirements for petroleum products was only 0.4 percent over 1953. Preliminary figures indicate demand in April was 2.7

NORMA-HOFFMAN OXIDATION TEST



This chart shows Norma-Hoffman oxidation test results with Du Pont "Ortholeum" 300 and Phenyl-alpha-naphthylamine in a Lithium based grease.

Multi-purpose greases with Du Pont ANTIOXIDANTS can broaden YOUR market

With the swing to multi-purpose greases gaining momentum every day, increasing the stability of your greases becomes a more pressing problem. And the problem is intensified as operating temperatures and speeds are pushed higher and higher.

Customers want multi-purpose greases because they cut inventories, eliminate misapplication, save lubrication time, require only one gun for most jobs, and give superior lubrication.

These customer advantages offer you a tremendous opportunity to broaden your present grease market. You can realize significant money savings, too, by making and marketing fewer types of grease.

But for your grease to rate as a multi-purpose grease, it must be stabilized with a high quality antioxidant. To help you increase grease stability as economically and efficiently as possible, Du Pont offers *two* antioxidants.

"Ortholeum" 300 Grease Stabilizer is highly effective as a metal deactivator, as well as an antioxidant. This quality is especially important in the heavy-duty industrial greases which come in contact with bearings containing brass.

Du Pont "Ortholeum" 300 also provides resistance to color deterioration, even under long exposure to light . . . an added sales feature for your grease.

Phenyl-alpha-naphthylamine gives excellent results in most non-catalyzed systems where the superior color stability of "Ortholeum" 300 is not essential. Where operating conditions are not too severe and competitive pricing is important, this Du Pont antioxidant can be used to increase stability at a relatively low cost.

Both of these Du Pont antioxidants also provide a low cost way to make your greases more valuable and attractive to the customer . . . and insure customer satisfaction and repeat business, too. So it will pay to try them out in your stocks. Write us today for free samples and more information.

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percent below that of April of last year.

Much can be done to alleviate the possibility of crude and product price cuts by holding imports, crude production and refinery operations to sufficiently low levels to offset this current condition of oversupply.

Union Renews Its Demands

THE OIL WORKERS International Union meets in Cleveland this month to touch off what it hopes will be a pyramiding reaction leading to nationwide bargaining.

The union will demand a "share-the-profits" general wage increase while incidentally voting itself into the Oil and Chemical Workers Union, the new organization formed for the eventual purpose of welding AFL, CIO and independent unions into one organization powerful enough to force the oil companies into bargaining on a nationwide basis.

The history of labor unions constantly repeats the fact that the greatest solidarity, the greatest numerical gains, are made when the leaders are able to rally the membership to a single, flaming issue. Usually that issue is the most universally sought-after, and therefore the most inflammatory, commodity that man has been able to produce—money.

In 1952 the Oil Workers' International Union mustered the greatest strength in its history with a demand for a 25-cent hike. That no such increase was gained—or perhaps even dreamed of by OWIU leaders—is beside the point. The campaign met with a measure of success because the workers were rallied behind a stirring issue.

Now two years later, the campaign for a 25-cent raise has been rephrased into a demand for "share-the-profits."

Undoubtedly, the OWIU membership will be told that their chances of sharing the profits will be enhanced by pooling their strength with the new Oil and Chemical Workers Union.

It is something more than a coincidence that a meeting of the Oil and Chemical Workers Union's policy committee will follow shortly, and it is also no happenstance that the chairman of that policy committee is Jack Knight, president of OWIU. By delivering his OWIU membership at this first important meeting of an Oil and Chemical Workers' group, and along with it a wage demand that could serve as a rallying point for all unions in the industry, Knight would be taking a step toward his long-sought goal—an organization strong enough to gain nation-wide bargaining.

Fast Tax Write-Offs

WHAT HAS BEEN the effect of issuing certificates of necessity? In some cases, granting these fast tax write-offs has been realistic—in others we now know that they were just guesses. It was a political decision to fight a butter-and-guns battle, superimposing full civilian requirements on top of partial military or mobilization requirements. This basic decision could not help but dislocate some refining and chemical market balances, resulting in present day over expansion in certain capacities. Toluene, benzene and styrene certificates of necessity are a good case in point (and close to the heart of our industry).

The total capacity in the United States on January 1, 1951, for toluene was 83 million gallons. The goal established for 1955 was 185 million gallons. *But* production level of toluene now stands at 120 million and marketers are hard put to sell all of it. The same is true of benzene. Production has jumped from 215 million gallons to 235 million. Though the goal set for 1955 was 375 million, this product is getting harder to move at its current production level.

Fortunately, these expansions took place in our petrochemical industry and can be diverted to other products within the refinery.

Styrene, however, is another problem. Styrene capacity in 1951 was 626 million pounds, but current production is only 472 million pounds even though a huge goal of 1.21 billion pounds was set for 1955. This was really a bad guess and it's going to take something more than a guess to take care of this excess capacity.

Outline for Tax Reform

HERE'S A SENSIBLE target in the matter of tax reform:

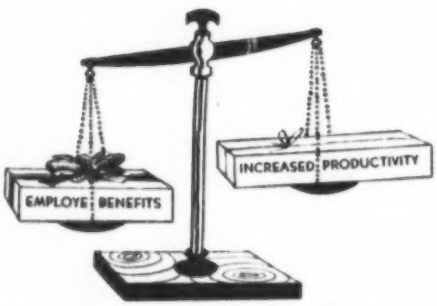
"We should aim for a system based on low rates assessed against a large and growing national output. The more we can increase our real wealth and income, the greater will be the gross tax yield."

This is the gist of suggestions made recently in a talk by Crawford H. Greenewalt, president of E. I. du Pont de Nemours and Company.

Tax reform which spurs the incentives to greater industrial development will lighten the load for everybody, he pointed out.

"Tax reform can promote national prosperity," Greenewalt said, "if it is based on the fact that government revenue and industrial progress are bound together in a single package and on the realization that an expanding economy means greater revenues with a lower per capita burden."

What price Benefits?



So you've bought a glamor package . . . but what proof have you that the effort in time and money has returned to your company an equal benefit?

Suggestion Systems Are Incentive Plans

You provide incentives that make people apply for work and hold them on the job. But what of the incentives that will make them want to work?

William S. Wilcox,
Socony-Vacuum Oil Company,
New York

Part I. INCENTIVE FOR WHAT?

NO BUSINESS is guaranteed against the results of a management's inability to get employes to cooperate with them. Employes are the people who must do the things that management must get done. Management must persuade or induce employes to help—must buy or enlist their co-operation—must pay the price in incentives that the individual employe will react to in a productive way. Effective employe incentives are competitive factors in business.

Aside from friendly relationships between supervisors and employes, management in general has not shown a very deep understanding of what effective incentives are—if the present popular programs are representative. Specifically, there is a demonstrable misunderstanding of what can be proven to be active incentives for voluntary, employe-initiated cooperation. Ask any executive who has hopefully authorized the spending of perhaps thousands of dollars for a typical employe communication program, these two questions.

- "What were the *attitudes* and *actions* of your employes which convinced you there was a compelling need to do this for (or shall we say *to*) your employes?"
- "What proof have you that the effort in time and money has returned to your company an equal benefit?"

These questions were asked of an executive of one of America's leading companies in its field—a company that has received wide publicity as a practitioner of advanced employe relations. His answer, given before a group of conference members was: "I don't know but I'm going to take a couple of days and find out!"

In the field of promoting individual incentives, strangely enough, management has been quite naive—forgetting apparently, that there can be a tyranny of fruitless programs which defy measurement. This reference is not intended to be critical; it merely demonstrates that even our most effective managers are as apt to buy glamor packages as anyone when under the sway of a currently popular movement. Fashions are not peculiar to the cloak and suit industry.

Stimulus Necessary—No less an authority than Crawford H. Greenewalt, president of E. I. Du'Pont de Nemours & Company has said: "I look upon diminishing incentives as the most serious possibilities now facing business." Perhaps it is unfortunate that human beings should require lures of any kind as the price of initiative, but people being people, they will give their best efforts only when there is some stimulus, some promise, or some satisfaction associated with success.

In practice today, there are incentives held out by companies to induce people to apply for work. There are incentives to encourage employes to remain against the competitive attractions offered by other employers. Less common are the incentives which impel an individual employe to act beyond the routine of his job. Company offered incentives which induce people to apply for work can be lumped into the "wages, hours and working conditions," of the job. The incentives which encourage an employe to hesitate before making a change are the so-called "fringe benefits." These two groups of incentives—pensions, insurance, thrift plans, stock purchase, holidays, paid vacations, disability and sickness pay, free or subsidized meals and the like—are looked to by a great majority of managements as guarantors of voluntary, self-initiated co-operation. As a matter of fact and experience, they often produce a result very different from what was intended. They do attract good prospects for employment. Many times they are the deciding factor in the employe's decision to stay put. He can't afford to give up his service benefits. On the debit side of the company ledger, however, as these "incentives" increase the earned benefits for the employe, they tend to produce neither self-initiated cooperation nor wilful non-cooperation. They often result in unquestioned and unthinking conformance to the established order of the business routine. They reduce employes and output to an average something. The usual employe with a large vested interest in his personal security is not apt to jeopardize his standing by self-initiated cooperation. So with the passage of time, the active appeal of those costly "incentives" become a power for the maintenance of a status quo. They result in a constructive loss to the company of employe initiative and originality. Despite this result, these static "incentives" have become normal and permanent additions to the competitive factors of business, and in fact in some circles are being deified as social responsibilities.

Merit Raises Fewer—Historically, management has leaned heavily on the possibilities for individual merit increases and promotions as incentives to employes for superior performance. They are still the most appealing incentives that business has to offer. The effectiveness of these incentives is being steadily whittled away by management. In many companies today, the

People, being people, must have incentives to do their best

You encourage people to seek the job . . . **. . . and to stay on the job.** **But are you making them want to DO the job?**

probabilities of an employe receiving a merit increase is inversely proportionate to the effectiveness of the company's job evaluation program. The unpublicized result of most job evaluation programs is the slowing down and for many individuals practically eliminating individual merit increases. At the same time the possibilities for recognizing good work by merit increases is restricted to a narrow range for all other employes subjected to it.

One of the chief virtues claimed for a job evaluation program is that it "depersonalizes" the evaluation of each job. The incentive potential has been weakened in those companies whose salaries and wages are subject to a formalized program based on standardized job evaluation. This is an incentive loss that cannot be replaced by blanket cost-of-living or across-the-board increases.

The other historic incentive—promotion—has lost practical meaning for a vast group of employes. At the present rate of executive turnover in any selected company in any mature industry, no sure opportunity for advancement will occur for every capable employe ready and waiting for it. An objective survey in any typical company will show that in the jobs normally looked to as goals by the great body of employes, the tenure of office often covers most of the life of a working generation. This career longevity nullifies the incentive appeal of possible promotion. These incentives of merit increase and promotion will endure, but they are becoming too infrequent in fulfillment for them to be pressing and compelling goads to the individual employe in his daily work. We must look elsewhere for active personal incentives which impel employes to keep swinging until the game is over.

Opinion polls almost always show that the most prominent desires of the individual employe concerns the most important thing to him in the world—himself, his personality, his progress. He is willing, even eager, to cooperate if the price is right. The price is personal success and recognition—recognition that identifies his personality, his attainments and his skill. It is an inherent selfishness common to everyone. Logic shows that intelligent selfishness has been the driving and guiding force that has produced every advance that man has made. It is this natural urge that management has to provide for. The incentive to the employe should be such that recognition is prompt and full. The return to the business must be real and worthy of the recognition given to the employe. These two needs have been brought together in a surprisingly large number of companies in a diversified group of industries. To quote from a public statement of a typical company: "These years of experience have demonstrated that the plan is valuable to management and supervisors; (there) is ample evidence of its value to employes and to this may be added the individual recognition." Statements in like vein can be quoted from as many companies as have seriously tackled the problem of individual incentives in the same manner.

Suggestion Systems—A National Association of Suggestion Systems has more than 600 members. In a single reporting year, 152 of the member organizations installed 165,000 new ideas—each idea a voluntary, self-initiated gesture of cooperation by an employe. Each idea improved something already in existence. In addition to the improvement, an impressive number of employe's ideas returned a net savings to the companies totalling millions of dollars.

A working suggestion system is a powerful and productive incentive plan for management as well as employe if it is operated as a normal phase of the business. It is quite safe to assume that not one of the companies of that 152 just referred to could afford to maintain a corps of efficiency engineers sizable enough to ferret out the improvements suggested by the employes. In recognition of the benefit to the companies, ideas were paid for in amounts up to a high single award of $28,000. Every dollar paid out was for value received. Improved methods, more efficient practices, increased safety also produce their cost reductions without actually showing up immediately in dollars.

A telephone company recently stated: "In all the thousands of suggestions which we have received from employes, not one contributed a significant advance to the science of telephone communication." That is a normal situation. It is reasonable to expect in any industry, that over the years, not many laymen's ideas will contribute significant advances to the basic science. The usual employe rarely pretends to understand and is content to leave the problems and advancement of science to the scientists. There are things he does know. He knows the loss in time, money, duplicated effort, useless work, wasted materials—the unseen leaks that keep the costs up. That is the field in which he can be induced to suggest improvements—if management offers an incentive.

Management should solicit employes'

See INCENTIVES, page 226

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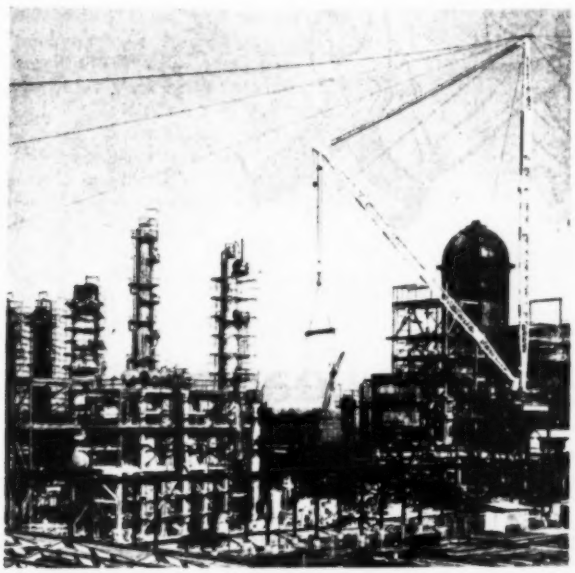


$17.3 MILLION was spent on Richfield's fluid catalytic cracking unit, part of which is shown above. Towers at left are fractionating columns. In huge vessels at right cracking reaction will occur and catalyst will be regenerated.

FROM THE FLOOR of the fluid catalytic cracking reactor chambers, workers look up to see these cyclone centrifugal separators which will recover finely-divided catalyst after regeneration and prevent its escape into the atmosphere.

What $40 Million Can Buy Today

Richfield Oil took this amount and bought for its Watson refinery an expansion that zoomed it to the front in the production of premium-quality gasoline.

TWO YEARS and $40 million after its expansion started, Richfield Oil Corporation has dedicated new refining facilities at Watson, Calif. Representing the "last scientific word" in petroleum processing equipment, the new units and the increased processing efficiency built into existing installations give Richfield a refining plant unsurpassed anywhere for the production of premium-quality gasoline and other petroleum products.

Emphasis of the expansion was placed primarily on quality of product. While the plant's capacity for processing crude oil will be increased only about 7 percent in volume because of the expansion, the yield of premium-quality gasoline from each barrel of crude will be increased by about 20 percent.

New Construction—Largest of the new units and one of the largest of its kind in the world is the fluid catalytic cracking unit, with a capacity of 63,000 barrels a day. This $17.3 million unit will produce high-grade gasoline and gasoline components, including hydrocarbons for alkylation and polymerization. The new 60,000-barrel-a-day vacuum still supplies the raw material which the fluid cat cracker converts to gasoline, and the new polymerization unit adds enough capacity to the polymer production to energize about 24,000 barrels a day of new gasoline. New equipment has nearly doubled the capacity of the alkylation unit.

Modernized Equipment—Improvements in the modernization on the combination crude and thermal cracking units have increased capacity to 80,000 barrels a day, an increase of 33 percent. The two Thermofor catalytic cracking units, with a combined capacity of 30,000 barrels a day, produce high-quality gasoline components. Other improvements include the super-fractionation unit, the crude distillation unit and auxiliary units.

Added Feature—New and previously installed devices to prevent air contamination at the refinery represent an investment of $6,737,431. This amount gave the refinery a system incorporating every applicable scientific anti-smog device known.

All in all, it would seem that Richfield bought a lot of new plant for its $40 million.

More Construction Items
Page 196

Engineers as Followers and Leaders

There are three leadership approaches—autocratic, democratic and free rein. To learn in what group you fit best, as follower and leader, read this article, then take the test.

Auren Uris,
Research Institute of America,
New York

WHAT KIND OF people are engineers, anyway?

You've seen engineers' income, hours worked, turnover rate, absenteeism, surveyed, averaged and charted. Any group, of course, may be studied on the basis of a shared activity. But how about engineers as people, as psychological beings?

Consider statements like these, for example:

"Engineers are easy to deal with."

"Engineers are tough to deal with."

You've surely heard engineers cheered or verbally sent to the showers in some such summary fashion. Is there really any justification for such group evaluation? Do engineers, psychologically speaking, represent a type of *homo sapiens* separate and apart from their fellow humans?

Engineers under the Microscope—A recent study provides an interesting and revealing insight into the psychology of engineers as a group. The leadership and followership tendencies of an ASME group meeting on Long Island were tested. Included were men involved in research and development, design, standards, liaison, and production.

Before getting into the study results, here's some background information that will put the study in perspective.

A New Approach to Leadership—Within the last few years a somewhat new concept of leadership and followership has been developed. It's a flexible approach, and attempts to right the balance brought about by an overemphasis on democratic techniques.

There's no question but that democratic leadership has much to recommend it. The trouble is that in concentrating on the virtues of this one method, many people lost sight both of the handicaps of the democratic techniques and also of the virtues inherent in other possible approaches.

A re-examination of the leadership facts of life as they actually exist rather than as the theorists would like to see them, reveals this state of affairs: There are three leadership approaches or tools that may be used in leading a group of engineers—or any other type of group. Each of these three methods, under given conditions, has certain advantages. Each of the three methods likewise has certain disadvantages.

ENGINEERS in MANAGEMENT

Here are the three leadership tools, and a brief description of each.

Autocratic leadership. Using this method, the leader assumes full responsibility for all group action. Obedience is his main request of subordinates. Policy and decision-making are his babies.

This approach is best when group members are inexperienced, dependent, or insecure. Or, when a critical situation requires immediate aggressive, single-minded action.

Democratic leadership. The leader draws ideas and suggestions from his group by discussion and consultation. Group members are encouraged to join in setting policy and in developing the regulations by which the group as a whole is to live and work.

This type of leadership is particularly effective where a work-group is cooperative and capable of carrying out group responsibilities. Or, when the benefits of group thinking are desirable.

Free rein. The leader exerts minimum control. He's on hand mainly to provide materials, information and so on.

This leadership method is particularly suited to individuals whose training and experience equip them to function pretty much on their own. Or, with groups—such as engineers—

where individual imagination and initiative, given free play, best stimulate group progress.

Your Followership—The "flexible" leadership concepts were used to develop two tests, one for leadership tendencies of individuals, the other for "followership" tendencies.

(These tests are reproduced at the end of this article. You may take them yourself, and evaluate your score, using the scoring instructions provided.)

An individual's "followership" is defined as the type of leadership under which he prefers to work. It is also likely to be the type of leadership under which he will find most emotional satisfaction in his work, and under which he will be most productive.

Followership can be related to the three leadership approaches previously described, in this fashion:

1. **Autocratic** leadership is what you prefer if you—
   - . . . are most efficient working under complete and detailed instruction.
   - . . . show a marked respect for firmness in your leadership.
   - . . . accept authority unquestioningly.

2. **Democratic** leadership tends to be preferred by those who—
   - . . . like to consult with you on departmental problems rather than take the position of "That's your headache!"
   - . . . are active participants in productive group meetings.
   - . . . apply the principles of mutual respect among themselves.

3. **Free-rein** leadership attracts those who—
   - . . . place a high value on initiative and want to be self-reliant.
   - . . . seem to work best when given a completely free hand.
   - . . . are capable of assuming full responsibility for their actions.

Implications for Engineers—The ASME group scores made in both the leadership and followership tests were compared to those of a so-called "normal" group. Here are the figures in the leadership area: The percentages indicate that strength" of the tendency towards the type of leadership indicated:

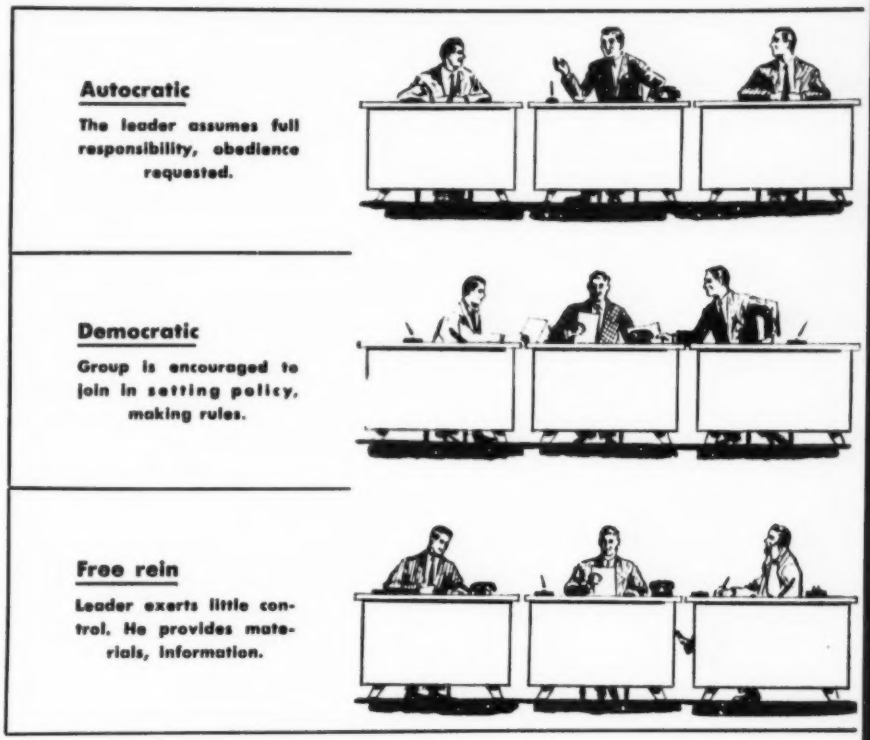
Leadership Ratings

Autocratic responses:
- Engineers .....23 percent
- Normal .....25 percent

Democratic responses:
- Engineers .....48 percent
- Normal .....44 percent

Free Rein responses:
- Engineers .....33 percent
- Normal .....31 percent

Three Approaches to Leadership of Engineers . . .


Autocratic
The leader assumes full responsibility, obedience requested.
Democratic
Group is encouraged to join in setting policy, making rules.
Free rein
Leader exerts little control. He provides materials, information.

Interpreting the Results—The percentages above indicate relatively little difference between the engineering group and the "normal" group. The differences in scores are too small to be significant.

What this means is that, as far as the leadership tendencies of the engineering group tested, they were in no special way distinguishable from an average business group. There is the some marked preference for the democratic method, with the autocratic and free rein responses approximately equal.

It should be pointed out, however, that while the "normal" group shows only a 6 percent difference between its autocratic and free rein responses, the engineering group shows a difference of 10 percent. As you will see, this percentage—the difference in attitude towards autocratic and free rein methods—jumps decidedly in the followership test scores shown in Figure 1.

Explanation?—How can the group engineering score be explained? There are two pretty clear implications, probably not unrelated:

- The kind of people who chose engineering as a profession like to work on their own, with a minimum of guidance. They want to be left on their own initiative, within the framework, of course, of the goals set them

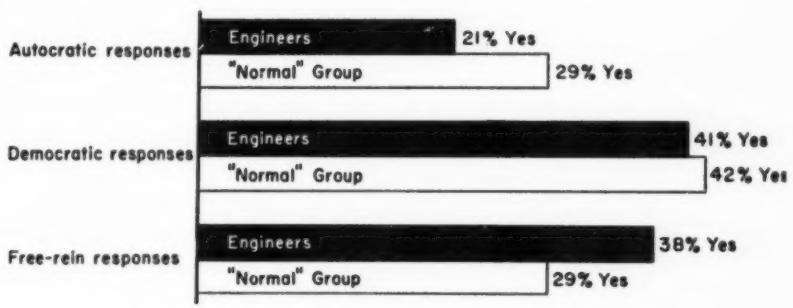


Figure 1
(Courtesy Research Institute of America)

Followers and Leaders . . .

by their superiors. This same character trait, incidentally, probably applies to professional people in general, doctors, lawyers, writers, and so on.

• The conditions under which supervisors work tend to develop those habits, and preferences that go to make for self-reliance, and the exercise of personal initiative.

Test Yourself—By taking the leadership and followership tests that follow, you'll be able to check your own findings against the group results given above.

No claims are made, as yet, for the scientific validity of these tests. But on the whole, individuals tested have agreed that their scores have a relation to their actual work experience. Even more to the point: those who have taken the tests have suggested personal gain in the increased insight into their own superior-subordinate job relationships.

Leadership Test

The questions below can reveal to you in approximate terms the type of leader you tend to be. Some of the questions you will be able to answer offhand. A few may require careful thought. But answer all the questions, and answer them as honestly and accurately as possible. Where the question asked has no ready answer from your experience, indicate what you believe you would do or think in the situation described.

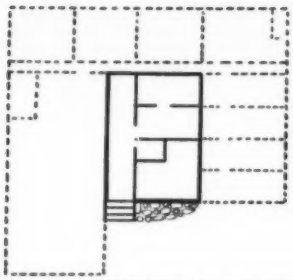
	YES	NO
1. Do you enjoy "running the show"?	( )	( )
2. Generally, do you think it's worth the effort to explain to subordinates the reasons for a decision or policy before putting it into effect?	( )	( )
3. Do you prefer the administrative end of your leadership job—planning, paperwork, and so on—to supervising or working with your subordinates?	( )	( )
4. A stranger comes into your department and you know he's the new employe hired by one of your assistants. On approaching him, would you first ask his name rather than introduce yourself?	( )	( )
5. Do you keep your people up-to-date on developments affecting them?	( )	( )
6. Do you find that in giving out assignments, you tend to state the goals, leave methods to your subordinates?	( )	( )
7. Do you think that it's good common sense for a leader to keep aloof from his people, because in the long run familiarity breeds lessened respect?	( )	( )
8. Comes time to decide about a group outing. The majority prefer to have it on Wednesday, but you're pretty sure Thursday is better for all concerned. Would you put the question to a vote rather than make the decision yourself?	( )	( )
9. If you had your way, would you make running your group a push-button affair, with personal contacts and communications held to a minimum?	( )	( )
10. Do you find it fairly easy to fire someone?	( )	( )
11. The friendlier you are with your people, the better you can lead them. Correct?	( )	( )
12. After considerable time, you dope out the answer to a work problem. Your assistant promptly pokes it full of holes. Would you be annoyed that the problem is still unsolved, rather than become angry with the assistant?	( )	( )
13. Do you agree that one of the best ways to avoid problems of discipline is to provide adequate punishments for violations of rules?	( )	( )
14. Your way of handling a situation is being criticized. Would you try to sell your viewpoint rather than state that, as boss, your word is final?	( )	( )
15. Do you generally leave it up to your subordinates to contact you, as far as informal day-to-day communications are concerned?	( )	( )
16. Do you expect subordinates to feel personally loyal to you?	( )	( )
17. Do you favor the practice of appointing a committee to settle a problem rather than stepping in to decide on it yourself?	( )	( )
18. Some experts say differences of opinion within a group are healthy? Agree?	( )	( )

Followership Test

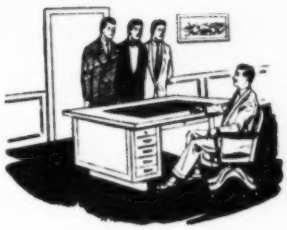
The questions below tell you the type of leadership you prefer. Whether or not you now work under a superior, you undoubtedly have done so in the past. Answer the following questions, keeping in mind what you have done or feel you would do in the situations described.

	YES	NO
1. When given an assignment, do you like to have all the details spelled out?	( )	( )
2. Do you think that, by and large, bosses are bossier than they need be?	( )	( )
3. Would you say that initiative is one of your stronger points?	( )	( )
4. Do you feel a boss lowers himself by palling around with his subordinates?	( )	( )
5. In general, would you prefer working with others to working alone?	( )	( )
6. Would you say you prefer the pleasures of solitude (reading, listening to music) to the social pleasures of being with others (parties, get-togethers, etc.)?	( )	( )
7. Do you tend to become strongly attached to the bosses you work under?	( )	( )
8. Do you tend to offer a helping hand to the newcomers among your colleagues and fellow workers?	( )	( )
9. Do you enjoy using your own ideas and ingenuity to solve a work problem?	( )	( )
10. Do you prefer the kind of boss who knows all the answers, to one who, not infrequently, comes to you for help?	( )	( )
11. Do you feel it's OK for your boss to be friendlier with some members of the group than with others?	( )	( )
12. Do you like to assume full responsibility for assignments, rather than just do the work and leave the responsibility to your boss?	( )	( )
13. Do you feel that "mixed" groups—men working with women, for example—naturally tend to have more friction than unmixed ones?	( )	( )

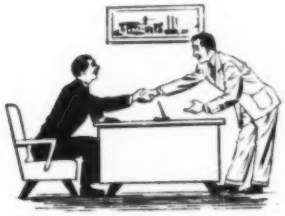
See FOLLOWERS AND LEADERS, Page 126



Know what the management structure of your company must be.



Select candidates who have the qualifications required by the jobs.



Establish a simple method of appraising the candidates selected.

Provide the training necessary to complete the candidate's experience.

Growing a Good Executive Crop

An executive in a company whose management development program has long served as a model, tells how to find and improve leadership.

John R. Suman, Vice President,
Standard Oil Company (New Jersey), New York

THE MANAGEMENT DEVELOPMENT program of Standard Oil Company (N. J.) was built on four fundamentals:

1. Know what the management structure of your company must be.
2. Select candidates who have the qualifications required by the jobs.
3. Establish a simple method of appraising the candidates selected.
4. Provide the training necessary to complete the candidate's experience.

Knowing what the management structure of your company must be means plotting out on paper an organizational course not only for present needs but one that will also ideally meet conditions in the future. This course contains two parts, the first being a manual or guide which describes in general the principles and objectives of a company, and, in detail, what each position in the organization involves. This guide, for example, outlines duties and responsibilities of executives who will fill the jobs, the bounds of the authority to be exercised, and the relationships each executive must satisfactorily maintain with other individuals or with groups within the company. The other document personalizes this guide. It is the organizational chart of a company, job by job. Upon it the names of candidates for specific positions will be entered and reviewed from time to time.

This double-barrel course is really the expression of management's hopes

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of what its present organization can grow to become—more efficient, more responsive to the pressure upon the company, giving more room for individuals to be happy and productive men and women. The course will do this successfully only if both the organizational manual and chart remain flexible instruments. Changing conditions will mean different executive duties and it is important that this need for change be recognized.

Job of Selection. The second fundamental, selection of candidates who have the qualifications required by the job, is the heart and soul of any management development program. Selection provides a working list of specific people who show the best prospects for carrying on a company's management. Listed on the organizational chart will be the "replacement table" of those persons who seem to have the essential qualities of experience, integrity, growth potential, cooperativeness, and technical competence, along with the willingness and ability to accept responsibility and make decisions.

Any worthwhile selection program will not put excessive emphasis upon promotion. Managements are unwise to think and candidates often disillusioned in believing that selection means automatic elevation to a higher

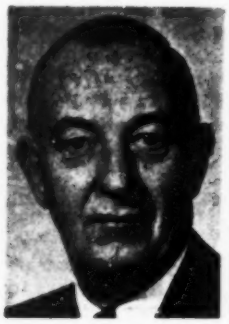
See EXECUTIVE CROP, Page 122

Engineers must communicate, these industry authorities say . . .

M. A. Coyne

H. L. Samuelson

S. L. Starks


W. L. Stabler

K. B. Bernhardt

Bacon Said It First!

And industry authorities are saying it again to ambitious engineers: Read widely. Participate in your technical societies. Learn to write better.

Al Reese,
Petroleum Refiner Staff

SIR FRANCIS BACON said it first: "Reading maketh a full man; conference a ready man; and writing an exact man . . ." And industry authorities are still saying it to engineers:

- Read more technical magazines and books;
- Participate in your technical societies . . . learn to conduct meetings . . . to speak with facility;
- Learn to write better papers and reports.

These were the points most emphasized in replies to a PETROLEUM REFINER question: If an engineer's company lacks an adequate executive training program, how would you advise him to prepare himself for advancement?

In such a situation, said W. L. Stabler, manager of Organization Planning division, E. I. du Pont de Nemours & Company, Wilmington, Del., an engineer "should take full advantage of opportunities to acquire facility in writing, preparing reports, and conducting meetings."

"Join and actively participate in technical societies . . . write technical papers," advised Martin A. Coyne, manager of personnel, The M. W. Kellogg Company, New York.

"Seek improvement in writing and speaking abilities," urged K. B. Bernhardt, director of personnel, Inorganic Chemicals division, Monsanto Chemical Division, St. Louis.

An engineer should "attend technical societies, conferences or other meetings within his field, participate in group discussions, committee activities and other similar company functions," prompted H. L. Samuelson, manager of executive development, Standard Oil Company of California.

"Become a member of scientific and technical societies," urged S. L. Starks, director of technical employment, The Dow Chemical Company, Midland, Mich. "I feel," he added, "that most young engineers are too conservative in the investment they make in relation to scientific and technical magazines and the choice of new books."

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Human Relations, Too—Other than technical material, Starks advised engineers to read widely in human relations—a field given scarcely less emphasis than reading-writing-speaking by those who participated in the symposium.

An engineer, said Stabler, must "recognize fully the fact that if he is to attain ultimate management assignment he must recognize the individuality of his associates. In this connection, he must further recognize that his ultimate advancement may be strongly dependent upon his ability to work through and with people rather than to obtain his objectives through selfish interests motivated by an obvious desire to advance his own interest at the expense of others."

Also, said Stabler, he should:

- Take full advantage of on-the-job opportunities to acquire experience in more than one line of activity.
- Constantly seek the counsel and advise of his superiors regarding his performance, and ways and means in which he can improve himself, particularly if his company does not have a formal appraisal or performance review program.
- Constantly strive to demonstrate better than average interest in, and enthusiasm for, his assignment.
- Constantly strive to expand his

See COMMUNICATE, Page 122

. . . and here's some advice on how to do it better.

Are you a goozler?

Are your ducks lined up?

Is your English telegraphic?

Communications Make the Manager

The successful executive spends most of his time communicating. He needs facility in business correspondence, public speaking, and technical writing.

Robert W. Hays, Assistant Professor,
Southern Technical Institute,
Chamblee, Ga.

THE SUCCESSFUL executive spends most of his time communicating his ideas to others.

Skill in communicating, then, is almost as important in industry as are technical and managerial skill.

Business Correspondence

Alert industrialists and businessmen have freed themselves from the trite, wasteful, bewhiskered old expressions dictated in business correspondence a generation ago. Instead of clinging to time-worn, retreaded expressions such as "I am in receipt of yours of the 29 inst . . .," the alert dictator remembers the first maxim of effective letter writing: a letter worth the approximately 50 cents it costs must win the reader's favorable attention. It must avoid the trip to the "circular file."

An application of practical psychology has made warmth and personality the most arresting characteristics of the modern business letter. The businessman should adopt the proper mental attitude as he begins to dictate. The alert dictator recognizes that first, his reader is an egotist who may have slight interest in the letter or in its author. Therefore, the most important pronoun in writing effective letters—letters that get results—must always be "YOU." In fact, a businessman may adopt this rule-of-thumb to test the effectiveness of his letters: "I," "we," or the name of the writer's company should not appear as often as the word "you" or the receiver's name. For if the letter contains a preponderance of "I's," it will probably not interest the reader.

"Take the other person's point of view" is an axiom surely practiced by

ENGINEERS in MANAGEMENT

successful salesmen; furthermore, this axiom involves much more than simply counting pronouns. For even a letter which passes the above-mentioned rule-of-thumb may not reflect genuine concern for the other person's point of view. This rule of thumb is no more than a minimum standard.

This proper mental attitude should be a question: "What does the reader of this letter need that I want to supply?" Or, before writing an adjustment letter or a claim letter, the businessman should ask himself: "What does the reader expect, and how will what I intend to say affect him?" Unfortunately, too many businessmen, recognizing that there is nothing new about this approach, scoff at such questions. Such an approach seems too "pat." Yet most business people can remember letters from friendly executives who in writing business letters forgot the most elementary principles of human relations.

The effective letter then, must display warmth, friendliness, and consideration for the reader's personality. It should follow the principles of personal conversation.

Format Important—Probably the next most important feature should be the form, format, and paragraphing of a letter. Here, the businessman must depend upon his secretary's cooperation. Certainly, the executive must emphasize to his secretary that a letter is a salesman: As the company putting its best foot in the customer's door, the letter must always present a neat, balanced appearance. Business executives who complain that their secretaries do not know how to transcribe a letter should understand that first,

secretaries usually learn in business schools several obsolete letter forms as well as the modern block form, and that second, every executive has the same responsibility to his secretary as to his other employes. He must let her know the quality of work he expects her to produce, or he will not get the quality of work he wants.

Unless the executive dictates his own paragraphing, he should remind his secretary that readers of letters, like readers of advertising, appreciate "white space." Hence, a paragraph in a letter should usually be shorter than a typical paragraph in this magazine, in a text book, or even in a news story. The opening paragraph especially should be short and concise; if possible, it should give the reader a thumbnail sketch of what the letter concerns.

The secretary should also learn, if she does not already know, how to center the letter on the effective page (the page excluding the letterhead and any printed matter at the foot of the stationery). Usually, the left margin should be about 18 elite typewriter spaces wide (about 1½ inches), and the average right margin about the same. However, if the secretary has a typewriter which permits justifying the right margin—making all the lines come out flush the right and left margins should be about equal.

Keep It Short—Finally, the executive should eliminate unnecessary wordage and wherever possible limit his letters to one page. Often, he can save space by preparing a rough outline of what the letter will contain *before he begins to dictate*. At least, outlining will usually accomplish two objectives: eliminating extraneous ideas and forcing the dictator to present his thoughts more concisely.

Concise writing is extremely important in preparing business letters. Far too many executives think about what they will say only after they begin to dictate. "Goozling," using the old stereotyped expressions of Victorian correspondence, usually results. For example, a goozling mind would produce the following paragraph:

> I am in receipt of yours of the 16 inst., and I beg to inform you that this letter will be the acknowledgement of your application for credit account.

The executive, gazing out his office window, vainly tries to devise an appropriate opening remark. Because his ingenuity fails him, he takes the easiest course (he thinks) by uttering sentences—noises—which really show no thought. The same executive would vehemently deny that he talks that way; and indeed, he probably does not goozle in conversation. Instead, over the telephone he would probably tell Mr. Jones something like this:

> I'd like to thank you very much, Mr. Jones, for your letter of March 16, in which you applied for a credit account.

Little imagination is required to avoid goozling. Usually, avoiding goozling and being natural and friendly are complementary aims.

The executive who does not feel at ease in dictating should determine to avoid the old stereotypes, even though more natural expressions require thought. The worst sinners on the list of goozling expressions include "we are in receipt of" which means no more really than that the mails are functioning properly. The dictator should instead say, much more naturally:

> "Thank you for your letter . . ."

Other goozling expressions are

> "It is my earnest desire that you . . ."

This is a word-wasting expression. Instead, the dictator should say:

> "I certainly hope you . . ." Or "I beg to inform you . . ."

Why should an executive beg anybody to do anything? Instead, he should simply inform his reader.

Even worse than occasional goozling (which shows merely that the dictator has not caught up with modern methods) is the rudeness some dictators unconsciously display. For example, the phrase "You claim in your letter . . ." seems harmless. But it casts doubt on the reader's veracity or sense of propriety. Equally as irritating is the implication that the reader has no sense of reason: "You ought to realize that we cannot extend open accounts to a customer with his first order." Perhaps the dictator must refuse to give the customer an open account; but the dictator should never insult an applicant. Rather, by subtle flattery, the dictator points out that his reader, as a businessman, knows the steps through which reputable firms, (such as the reader's) establish open accounts.

Final Test—Finally, the business letter must pass an acid test: Will it gain the desired results and still retain the reader's good will (unless the letter is the last of a collection series, of course)? If the dictator has carefully dictated the letter with the reader in mind; if he has trained his secretary to preserve the neat appearance that every reader has a right to expect; if the letter is clear and concise with a minimum of wasted verbage; and if the letter will not offend the reader through unintentional implications; then the dictator may feel certain that it will be read and that it will probably get results.

Public Speaking Weighs Heavily

Probably every white-collar worker, as he starts up the ladder of management, observes incongruity between what he learned in high school, technical college, or university and what he observes in actual business practices. For, contrary to what most of his teachers may have said, technical knowledge of a job is not enough. Almost any organization employs men with plenty of brains and education who have only partially succeeded. Somehow, being able to speak effectively, among other qualifications, often weighs as heavily in promotion as do diligence, hard work, and skill. For American businessmen are talkers, and the American executive must be at ease around a conference table or on his feet in front of a group.

The typical American industrialist must be able to speak effectively because he speaks on many occasions. In the plant, office, or refinery, he talks to groups of workers. Around the conference table, he meets others of his own level; at lunch or at night, he associates with other executives in business and civic organizations. And because he has many opportunities for talking, he must be able to communicate effectively through speech. Discussions of communication must therefore include at least some comments about public speaking.

Any speaker should understand that before he can speak effectively, he must know just what his listeners expect. In a group meeting, in a conference, or on almost any occasion, the listeners expect that the man who is talking will display four characteristics:

Worthwhile information
A concise presentation
An interesting presentation
A logical approach.

A speaker must compete with distractions, the natural inattentiveness, the individual worries, and the limitations of listeners. Therefore, he must usually convey worthwhile information. (The industrial speaker seldom speaks to entertain.) Moreover, because the speaker competes with distractions and other interests, he must offer his facts and opinions concisely and interestingly; an audience will usually tolerate even disagreeable opinions, but it will not accept bore-

dom. Finally, most listeners expect a logical approach to any serious subject.

Be Prepared—Nearly any speaker can meet these requirements by ample preparation. The speaker, before he arrives in the conference room, and certainly before he begins to speak, "gets his ducks in a row." If his discussion hinges on existing legislation, he checks the law or interviews his legal counsel. If his thoughts will concern past records, he checks his own or the corporate files. If he expects disagreement from his fellows or his subordinates, he plans to reconcile disagreements while he is talking. He never permits himself to appear unprepared. The speaker who "talks himself out on a limb" arouses at the best pity and at the worst scorn.

As in almost all communication, making an outline is a safe procedure in public speaking and conference leading. An outline insures adequate preparation and a logical approach: an outline frees the speaker's mind so that he will probably present an interesting talk. To a conference leader his outline is most vital because it enables him to cover all the necessary subjects, to allot the proper amount of time to each subject, and to prevent the conference from disintegrating into an unproductive "bull session."

Any speaker, whether leading a conference or serving as the main speaker before a gathering, should try to avoid any irritating mannerisms. Mannerisms of voice control are especially difficult to overcome, but two other distracting habits can be easily avoided: the "and-er" habit and the habit of "fiddling" with keys or other gadgets. Anyone who habitually says "and-er" at every pause can enlist the aid of his wife or his secretary to help him cure himself of this habit. He may ask his wife or his secretary to whistle each time he says "and-er."

A speaker can avoid "fiddling with gadgets" by emptying his front pockets before he begins to speak. The speaker should put his change in his wallet and any keys or other gadgets in his back pockets. Besides curing the habit of distracting the audience by fiddling with gadgets, removing these gadgets will free a speaker's hands for effective gesticulation.

Finally, the audience wants a speaker to organize his thoughts before he begins to speak. Any educated audience rightly expects a speaker who consumes its time to assume an attitude of calm, confident competence.

Technical Writing, Worth a Premium

The growth of complex line and staff organizations in almost all industries has necessarily involved intracompany "paper-mills." Because in a large industry the individual department often functions almost as a separate business, executives frequently write communications between departments. Especially, top management passes along written orders and directives. This growth in paper work demands that countless hours of payroll time be spent in reading; consequently, top management in almost any industry places a premium on skill in technical writing.

All technical writing, whether it represents recommendations, directives, job instructions, abstracts, progress reports, proposals, progress summaries, or investigation reports, should display four characteristics:

Conciseness and economy
Completeness
Logical order
Observance of grammatical and industrial conventions.

The advice to prepare an outline in planning any written or oral presentation of thoughts and facts applies even more to the technical writer's work. However, the outline assumes two stages in the technical report. First, the writer prepares a rough outline based upon what he already knows about his subject. This rough draft might be compared to the large scale chart a navigator of a ship uses before he begins to plot his detailed course.

After he has prepared his rough outline, the writer gathers his necessary data. Gathering his facts carefully will save the writer from embarrassment, for certainly nothing places a writer in a more unfavorable position than ignoring a pertinent company directive, a clause in an applicable union contract, a federal law, or a previous report. To help industrial writers, some plants maintain engineering libraries. *The Reader's Guide to Periodical Literature* and bibliographies of governmental publications may also prove valuable. Finally, almost any technical report should involve a survey of the various company manuals and discussions with the concerned supervisors or foremen. Meticulous attention to the facts embodied in his report will earn for the writer the reputation of never going off "half-cocked" of always organizing his facts.

Use Logical Order—His schedule usually permits the writer to make certain that this rough outline, in the light of his research, displays logical order. Nothing impresses a superior or a customer much more than does a report which evidences logical organization. If the report summarizes developments, the narrative form, with the details in chronological arrangement, usually serves best. A recommendation usually has this arrangement: recommendation, reasoning, answers to objections, and summary. Like the summary report, job descriptions or instructions should usually follow chronological order through a step-by-step account of what action the reader should take, with reasons given wherever possible.

Next, the writer prepares a rough draft. Beginning writers frequently slavishly observe the rules of grammar; and, indeed, observance of grammatical convention is expected of every responsible writer. But no writer should concern himself with grammar or the niceties of expression until he has completed a rough draft. In the rough draft, ideas alone should concern the writer. For instance, in the rough draft, if the writer inadvertently uses a plural verb with a singular subject, he should not divert his attention to correcting this minor error until he has completed his draft. A carpenter does not begin to plane a cabinet with 100-grit paper; he first will use a jackplane or heavy sandpaper. Similarly, the technical writer puts ideas down on paper and reserves the polishing of these ideas until he has written them.

After he completes his rough draft, the writer edits it for conciseness of expression and for observance of convention. He should particularly try to eliminate all of the wasted words. For example, the following expressions usually have more economical equivalents:

Wasted words	Equivalents
In spite of the fact that	although
Because of the fact that	because
Can and will	will
In the checking of	to check
Should this contingency arise	if this happens
In any eventuality	always
Under these circumstances	therefore

Almost any piece of technical writing will be read either by a superior whose time is worth more than the writer's or by a group of subordinates whose collective time is valuable. Hence, the technical writer recognizes that rapid, sloppy writing usually means slow, costly reading. He never ignores the opportunity to omit pad-

ding or unnecessary phrases, for the best formal business writing is "long on ideas" but "short on words."

Of course, conciseness must not run to an extreme. Telegraphic English belongs in telegrams and not in reports to one's superior. The technical writer should not strive for conciseness by eliminating the necessary "a's," "and's" and "the's."

The number of drafts through which a writer puts his report will depend upon two considerations: the importance of the report and the amount of time he can devote to the report. In writing any important report, the writer needs sufficient time to prepare a second draft; for a second draft will give the typist a clearer copy from which to copy the final draft. No matter how many drafts are prepared, the writer must accept responsibility for the copy which is submitted.

The writer's responsibility is a subject which itself merits comment. Many writers in business assume an attitude of "I'll let my typist worry about that." Such an attitude is both unwise and unrealistic. For whoever aids in preparing the final draft, the report in its final form is the writer's inescapable responsibility. If the report contains typographical errors, or if the typist has juxtaposed ideas or sentences, the writer must accept whatever consequences may result. And, as most businessmen will testify, companies have too few sufficiently trained stenographers and typists. In fact, the amount of space devoted to "help-wanted" advertisements for secretarial help is exceeded in most metropolitan dailies only by advertisements for salesmen. Many firms are forced to employ typists whose training is only sketchy. A writer displays extreme naivete in assuming that a partially trained typist will correct all of her errors.

Timing Factor—As in nearly all other activities, timing is important in submitting a report. To submit a recommendation critical of present operations when the writer is not matching his own work schedule will probably earn a superior's disfavor. Taking care of first things first is sound advice.

Briefly, then a technical report must evince

Mature judgment
Careful marshalling of facts
Consideration of the reader's time
Preparation
Obedience to conventions
Proper timing

No matter how brilliant its conclusions, the report which does not show these qualities will probably fail of acceptance. And, conversely, even a report which cannot convince the reader of its conclusions and recommendations will merit the reader's respect if it does measure up to these criteria.

Summary

The basic tenet of this series should by now be obvious: mere generation of ideas, or simply mastering the technical details of one's position is not enough. Just as a "coming" executive gives attention to his manners, his clothes, and his bearing toward others, so must he develop his skill in communicating his ideas to superiors and subordinates.

COMMUNICATE . . .

Sir Francis Bacon's prescription found still applicable—with additions.

Continued from page 118

knowledge of company operations through intelligent questioning of policies, methods and procedures so that he may obtain a working knowledge of the functions of others as related to the requirements of his own job assignment.

• Be considerate of the opinion of others; and in the case of his subordinates, particularly, he should feel a prime responsibility to develop their latent talents to the best of his ability, even though on occasion it might mean the development of an individual who might some day bypass him.

Coyne urged engineers to apply for professional registration and to associate with men who have already made a name for themselves in the profession.

He further declared that he is "becoming more and more convinced that an engineer who aspires to a top management job must develop those characteristics which he can use to motivate other people to work: enthusiasm, initiative, self-confidence, social sympathy, human relations consciousness, a wholesome attitude . . ."

Broaden Outlook—He also called for a broader outlook among engineers. "One outstanding weakness of technically trained men with whom I have contact is their seeming indifference to, or lack of real familiarity with, fields outside their own.

"I believe that it is important that they have a general understanding of other aspects of the business world. It seems to me that they can only do this by associating with others than engineers."

Bernhardt had these additional suggestions for those who would improve themselves:

• Application of the Golden Rule.

• Introspective diagnosis by means of an annual self-appraisal.

• Salesmanship of the personal resources of the individual by means of appearance, dress, and a certain amount of office diplomacy.

• Conservation of health through medical examinations and extra-curricular activities in sports or hobbies.

• The seeking of expert assistance where necessary in diagnosis, training, experiences, and evaluation.

EXECUTIVE CROP . . .

Continued from page 117

place in the managerial system. The main emphasis rightfully belongs on development, not promotion. Very often, men who are given special opportunities for development may keep the same jobs throughout the rest of their careers. But still the experience has made them far more capable and given them a much greater sense of real achievement than they would otherwise have had.

The methods of appraising the candidates selected, which is the third fundamental, will naturally vary from company to company. But any workable method of appraising managerial talent will probably result in determining what a man has in the way of qualifications, what is his potential for growth, besides what he will need in the way of additional training or background to equip him for a specific position. Periodic appraisals usually reveal whether selections on the so-called replacement table have been accurately made. They do so by showing whether a man is promotable, adequate or unsatisfactory. Based on these findings, the replacement tables can then be revised.

Good appraising of executives not only helps management, it is of great value to the individuals concerned. Sometimes it reveals an unrealized weakness—the lack of a foreign language, unfamiliarity with basic technical background, or something similar which can be corrected. What it

See EXECUTIVE CROP, Page 125

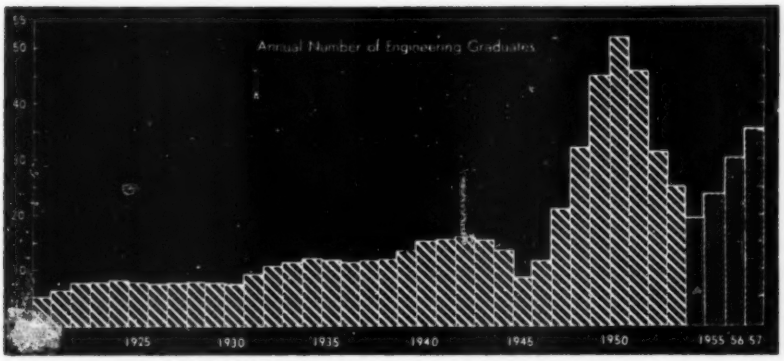

Figure 1. Annual number of engineering graduates (figures at left are thousands of graduates)

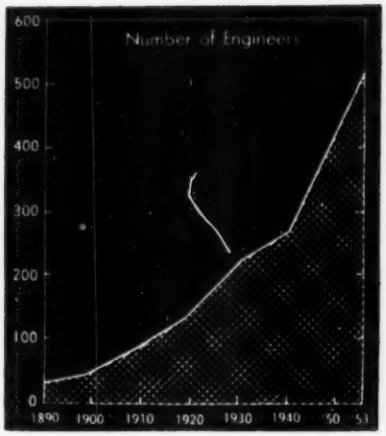

Figure 2

Engineering: The Profession With a Glittering Horizon

Twenty thousand new engineers are needed annually in the U. S. Serious shortage develops despite unprecedented supply of 140,000 graduates in three-year period.

Irving Ladimer, U. S. Public Health Service
Robert W. Cain, U. S. Department of Labor

A SERIOUS shortage of engineers has developed since mid-1950 despite the unprecedented supply of 140,000 new graduates in the three-year period 1949-51—far above the prewar average of 10,000 a year.

Engineers are needed to design and refine new and improved defense material as well as to develop new tools for further industrial progress. Not only are engineers counted to devise sufficient methods of manufacturing civilian and military ware and to give technical leadership throughout the production process, but they are needed, especially by the Armed Forces, to use fast and increasing stores of highly complex equipment.

In engineering fields, the men, money and materials triangle is not equilateral, but foreshortened by the manpower leg. The limiting factor is men—with training, competence and breadth.

There's even a shortage of women. Engineering is lately attracting and accepting the female of our species. Today the outlook for women is rosy. Only one co-ed in 2100 tries engineering, but if they stick at it, chances are good that they can break into this man's world. Sales engineering, demonstration, research and planning opportunities are better than at any time since World War II and are improving.

I. *The Supply-Demand Ratio*

Experience, Education and Executive Talent—Years ago, most engineers were self-taught, practical builders of machinery and instruments; surveyors; and constructors of bridges, roads, and canals. They became engineers after some informal education and on-the-job training. In the U. S., before the 19th century, prospective engineers simply apprenticed themselves to an established engineer or got a mechanical job in a factory or shop. The engineer was developed by *experience*.

ENGINEERS in MANAGEMENT

As science moved ahead and engineering became more complex, formal preparation became essential. When the U. S. Military Academy was opened in 1812, courses in science and engineering were offered. The first civilian engineering schools were founded shortly afterward. Engineering schools and schools of applied science were scarce until 1862, when the Morrill Act was passed, granting federal funds to the states for founding colleges of agriculture and mechanic arts. The number of engineering colleges increased rapidly, from 17 in 1870 to 85 in 1880 and 110 in 1890. Engineering schools furnished technical graduates in the development of the railroads, manufacturing and electric utilities.

By the 20th century, however, the rate of increase slackened. Agricultural and business education instead surged ahead. But World War I added impetus to engineering education. The engineer's contribution to the winning of the war effort focused interest on the profession. That interest has remained vital. Today nearly 200 schools grant engineering degrees (Table 1) and several hundred other schools offer some courses in engineering.

And the quantity has been matched by quality. American engineering education is recognized throughout the world. Our allies send their best students to this country for training. And, as is well known, American engineers are in constant demand in foreign coun-

Figure 3

tries. The second phase stressed *education*.

But, without doubt, the most potent quality is the engineer's executive and leadership talent in a technical world. His is a profession without visible horizon. From the relatively limited field of mechanical design and construction, the engineer has marched into new and expanding territories where his training and ability for commanding men and resources are recognized and rewarded. Several articles in PETROLEUM REFINER by W. C. Eldridge earlier this year italicized the critical demand for engineers as *managers*. Even the most academic and professionally minded schools are educating engineering students to accept *executive* as well as technical responsibility. Indeed, so well accepted has "engineer" become as a symbol of administrative competence and versatility that the term is being cheapened. Salesmen, office managers, fiscal and supply officers and, of course, machine tenders of all kinds wear the badge of engineer. But if imitation lessens the profession's prestige, it emphasizes its breadth of span and pushes up the demand for the truly skilled practitioner.

TABLE 1
Engineering Education

Regular Schools Granting B.A. Degree	192*
State colleges or universities	85
National, territorial, municipal	13
Denominational	22
Private, nonsectarian	66
Combined categories	6
"Cooperative Plan" Schools (Classroom and practical industrial experience combined, following the Cincinnati model of 1906, requiring 5 years for bachelor degree)	35
Enriched Curriculum Schools (Social studies added, requiring 5 years for bachelor degree)	15
Night Schools (6-8 years) (Enrollment 18,000 in 1951)	36

* 155 are part of a college or university and 37 are separate.

Needed: More Engineers—Even though engineers have increased from 40,000 in 1900, to 130,000 in 1920, and from 260,000 in 1940 and to more than 500,000 today, the number is far from adequate. The heightened demand is all the more amazing since the supply has expanded more than ten-fold over the last half century and nearly 100 percent since 1940.

Not only his the number of engineers been rapidly increasing, but the ratio of engineers to total industrial workers has also been steadily rising. In 1900 there was one engineer to about 255 workers. In 1950, there was one engineer to about 62 workers. Considering the complexity of modern technology, there is every reason to believe that this trend will continue.

Since these are the critical talents for defense, the shortage is of utmost concern to the nation. So say the Special Surveys committee of the Engineers Joint Council, the National Research Council, the American Chemical Society, and Government bureaus in defense and labor agencies, responsible for making sober estimates of requirements and resources.

II. *Defense Demands*

Over the long run, the profession will probably continue to expand substantially whether we enjoy peacetime full employment or sweat out standby mobilization. Under strictly peacetime conditions, demand for engineering graduates for replacements and additions has been estimated at 20,000 each year for the next ten years. Prolonged partial mobilization—our current situation—calls for about 30,000 new engineers per year. While defense production and development work are in the buildup stage, even more will be needed.

Since initiation of the defense mobilization program in mid-1950, engineering societies have been attempting to solve the profession's manpower problems. The Engineering Manpower Commission, set up in 1950 by the Engineers Joint Council and other groups, has demonstrated the importance of engineering to the national economy, cited the critical shortage of engineers and engineering students, and worked out plans for the draft, Universal Military Service, ROTC proposals, and registration of engineers.

An item of more than passing interest in this defense picture is the report of Dr. M. H. Trytten, scientific manpower specialist and government consultant. He recently compared U. S. and U. S. S. R. efforts in getting and using technical personnel. Table 2 shows his facts, based on 1951 statistics, with our slender superiority shown in bold face type:

TABLE 2

	U.S.S.R.	U.S.
Enrollment, high school	37,000,000	30,470,000
Enrollment, college	916,000	2,116,000
Ph.D. or equivalent degree conferred	5,500	7,700
Engineers graduated (1953)	43,000	24,000
Engineers in labor force	400,000	500,000
Scientists in labor force	150,000	243,000

The high college enrollment of which we are so justly proud, Dr. Trytten suggests, does not necessarily yield a high proportion of technically qualified leaders. In this country, many go to college to enrich their personal backgrounds. In Russia, enrollments "are more closely related to the needs of the Russian state for trained personnel for its activities . . . the yield in trained professional personnel from the Russian system is greater in numbers than is our own for the same number of students enrolled."

Simply in terms of meeting competition where it counts most, our engineering defense needs for now and for the long haul are increasing.

Chances are, therefore, that if the schools do not produce sufficient numbers, engineers as before will be siphoned from other employment to meet national requirements.

End of Part I. The concluding part will be used in an early issue.

Commerce Official Cites Need for More Engineers

Soviet Russia is turning out twice as many engineers as this country, it was warned last month by Undersecretary of Commerce Walter Williams.

He noted that the U. S. "has for a long time faced a serious shortage of scientists and engineers," and pointed out that the government is trying to provide support for scientific and engineering activities.

He declared that the number of engineering graduates in the U. S. has dropped from a high of about 52,000 in 1950 to a low of about 19,000 this year.

"This is a very serious situation and one which, if not rectified, could place us in a very disadvantageous position within a few years," he said.

EXECUTIVE CROP . . .

Standard of New Jersey vice president tells how to find and improve leadership in your company.

Continued from page 122

usually discloses, however, is how unbalanced in their backgrounds today's businessmen tend to become. Because of the nature of previous work experience, men are found to be greatly overweighted by certain aspects of a business, and only sketchily acquainted with the rest.

Learning by Doing. In providing the training necessary to complete the candidate's experience—which is the fourth fundamental—many companies make a man the understudy of someone and let him learn how to handle a job by looking on. This has the obvious disadvantage of passing along acquired faults, although there are times when there is no substitute for imitation. But there is a type of learning-by-doing which is far more comprehensive. And it has the added advantage of giving the trainee a chance to think and act for himself, as well as exposing him to new and stimulating experiences.

Most of this training can be acquired right in the company. Jersey, for example, has special courses designed to give executive talent a grounding in the basic techniques of management as well as in many specialized subjects. Along with these courses, a very extensive job rotation program is maintained. This gives promising candidates an acquaintance with many sides of modern business. Employes may work for periods with different affiliates, or sometimes in different departments of the parent company, so as to give them the kind of background they will need for greater responsibility. Jersey goes so far as to earmark certain positions as training slots make sure that they are filled at proper intervals with new faces. Opportunities provided by vacations or leaves of absence are quickly seized upon. Many production men, for example, who have spent a few weeks filling in for a vacation absentee in employe relations or in marketing jobs have come out with a new respect for the other man's work and greater personal stature for the experience.

Off-Job Training. Off-the-job training is important, too, in Jersey's executive development program. Very often men can learn more in a shorter time from specialists outside than they would shut up within a company. More than 400 members of the Jersey family, for example, have gone to advanced management training courses in places like the Harvard Business School, the University of Pittsburgh, the University of Western Ontario, The University of Houston and other institutions. Twenty-seven colleges and universities in the U. S. now offer these training courses as do institutions in Europe, notably in England, where executives from Jersey affiliates have also studied.

Fundamentals like the four outlined are useful only if they are put into practice. And they must be put into practice right at the top level of a company to be really effective. A group of Jersey's board of directors, for example, known as the Compensation and Executive Development Committee, meets regularly once a year with the top executives of affiliated companies and the heads of Jersey departments. At that time "replacement tables" are gone over carefully, possible job rotation assignments discussed and the chance given for all to be sure that the new executive crop is flourishing as it should.

Just as important as giving a man a chance to develop himself is the joint obligation not to let that development extend beyond the limits of physical and emotional capacities. A good manager, like a good machine, depends on physical well-being for top efficiency. His efficiency also depends on his doing the work for which he is temperamentally best suited. Many men, for example, who are presently doing good work in fairly responsible positions would be better off staying where they are. They may seem to have all the qualities needed for future growth. They may be intelligent, likeable, capable. But advancing them to positions of greater responsibility can sometimes have disastrous effects upon the individual concerned. The new jobs may result in anxieties which men cannot handle. The net effect is to make a man who was happy and productive in one spot nervous and faltering in his performance at another job.

Determining whether or not a man is fit in the physical and emotional sense is often a delicate decision. And it is one as much up to the individual as it is to the company. Industrial programs should make it possible for all executive candidates to develop a confidential relationship between themselves and company medical departments. Thus, by building up a medical history, each man knows what his limits are. Then when a transfer or new responsibilities are in the offing, the candidate can consult with the physician for an honest appraisal of whether the change is a good one or just a short cut to a nervous breakdown or a heart attack.

Such background information also makes it possible for company physicians to give very valuable advice to company management, not only where individual medical dangers are concerned, but in the broader field of reducing the elements that make for tension and the other ills associated with executive responsibility.

Early Faults. The Jersey program of executive development has been in operation long enough now to have learned a good deal from it. Some of the first findings to turn up were weaknesses. One of the big flaws was that men were in some cases being rotated too fast from job to job. Leading candidates for top jobs were being pushed toward them at a rate that was leaving them with no real sense of accomplishment in any one post along the way. The term "suitcase supervision" which sprang up at the time indicates the hurry in which the candidates found themselves involved. Most of this speedup took place directly after the war when there was great practical urgency to fill the managerial pipe line. With that situation behind, and a realization that maturity cannot be pushed upon people, Jersey has accordingly reduced the tempo.

Another beginning fault was the overemphasis put upon promotion. It is deceptively easy for executives as well as the candidates for executive posts to think of an executive development program chiefly as a conveyor belt to bigger jobs. Executive

development, if it is to do a company or individual its fullest good, is much more comprehensive. It enhances the capabilities of all men exposed to it whether they move up or not.

Jersey has not been discouraged by the fact that sometimes it may seem that too many men are undergoing development. You can never have enough good men in a company and usually normal attrition in the form of health hazards tends to balance the scale. Another balancing factor is the flow of trained men to other companies. That is not really Jersey's loss, for the company operates on the theory that no individual is indispensable. Jersey is, of course, sorry but prefers to look upon the experience as a gain for the whole industry if a man whose potential the company has been of some help in developing decides to go to work for a competing organization.

Rewards Great. The rewards of Jersey's program have far outweighed the mistakes. The very act of agreeing upon and writing down the principles of management has given them a kind of effective life they never had before. Now they are universally understood throughout our organization. They are available for all to read and, by reading, to understand what the philosophic foundation of our business is considered to be. They are available also for new executives in the future to judge, modify, and to improve upon in the light of changing times and ways.

In opening its own channels of communication from one management level to another, the executive development program has also made those channels available for communications of many other sorts. Executives in all of Jersey's affiliates have been brought closer together. The program has given Jersey a chance to understand one another's problems and to cooperate more readily in solving problems as they arise.

It has been found, too, that it is important to try and determine what intangible qualities make an executive and how they do so. The company's investigation in this field has just begun and will only be really valuable when it is made available to other companies and coordinated with what they have found.

The systematic inventory provided by the program gives all potential executives a chance to be fairly and frequently reviewed, to develop themselves to the limits of their capabilities and desires, and so be of greater service to themselves and to Jersey. Management today has a responsibility that it has rarely faced before. It must use, and develop to the utmost, large-scale facilities and techniques. At the same time it must maintain the importance of individual employes within the business system. Methods of helping men and women develop their powers are in themselves a demonstration of management's approach to these duties.

But, almost beyond its present importance is the future significance of such programs. It seems that the people who are now rising to positions of executive responsibility in business cannot help but be better equipped for their jobs because of the organized opportunity they have had to develop themselves. And, as their number grows, the character and ability of industrial management will continue to improve.

This paper is a condensation of a talk given at the annual spring meeting of the Pacific Coast District API in Los Angeles, May 6.

FOLLOWERS-LEADERS . . .

Continued from page 116

14. If you learned your boss was having an affair with his secretary, would your respect for him remain undiminished? ( ) ( )

15. Have you often felt that "he travels fastest who travels alone"? ( ) ( )

16. Would you agree: a boss who can't win your loyalty shouldn't be boss? ( ) ( )

17. Would you get upset by a fellow worker whose inability or ineptitude obstructs the work of your group? ( ) ( )

18. Do you think "boss" is a dirty word? ( ) ( )

Scoring

To get your score, follow this procedure for each test:

a. Ring all the question-numbers below which you answered "Yes".

Leadership

I. 1, 4, 7, 10, 13, 16
II. 2, 5, 8, 11, 14, 17
III. 3, 6, 9, 12, 15, 18

Followership

I. 1, 4, 7, 10, 13, 16
II. 2, 5, 8, 11, 14, 17
III. 3, 6, 9, 12, 15, 18

b. Count the "Yes" answers you've indicated for rows, I, II and III.

c. Fill in the three totals in the columns below.

Leadership

I.____autocratic tendency
II.____democratic tendency
III.____free rein tendency

Followership

I.____autocratic tendency
II.____democratic tendency
III.____free rein tendency

Evaluation

The following analysis applies to both your leadership and followership scores. In general, there are four possible types of scores:

High scores. Any category in which you scored from 4 to 6 "yes" answers is one toward which your inclinations are strong. Let's say, for instance, that your leadership score read like this: autocratic—5; democratic—3; free rein—1.

Your autocratic leadership tendencies would tend to be quite pronounced. That is, you would have a decided preference for an autocratic superior.

Low scores. Another possibility is that your score didn't go about three "yesses" in any of the categories. Here's a followship score of this kind: autocratic—2; democratic—2; free rein—1.

Behind low scoring you're likely to find an individual without strong feelings about working under any of the three types of leadership. He would do almost as well under a boss using any one of the three methods.

Balanced scores. A particularly interesting type of score is one of this kind: autocratic—3, democratic—3, free rein—3.

Evenly distributed scores generally reveal a personality sympathetic to all three methods. People who make this kind of score have a well-proportioned personality. It's a desirable balance. Under ordinary circumstances they will have less of a problem in adjusting to the realities of the superior-subordinate relationship.

Such a score, however, is not usual. The reason is that preference for the autocratic and free rein methods often require emotional outlooks which are directly opposed to one another. Such conflicting elements seldom are found within the personality of a single individual.

In most cases, balance is less perfect.

Let's say your scores were slightly off balance—3, 2, 1, for example. Your autocratic preference is there all right, but it's not too pronounced. Chances are, people with scores of this kind would find little more difficulty in functioning under a free rein leader than an autocratic one.

Unbalanced scores. A score that is high in one category, low in the other two, has clear-cut implications. Take this possibility, for example: autocratic—0; democratic—6; free rein—1.

It's a safe bet that a person getting this kind of score has a strong preference for democratic leadership. In addition, he has tendencies **away** from the other two types.

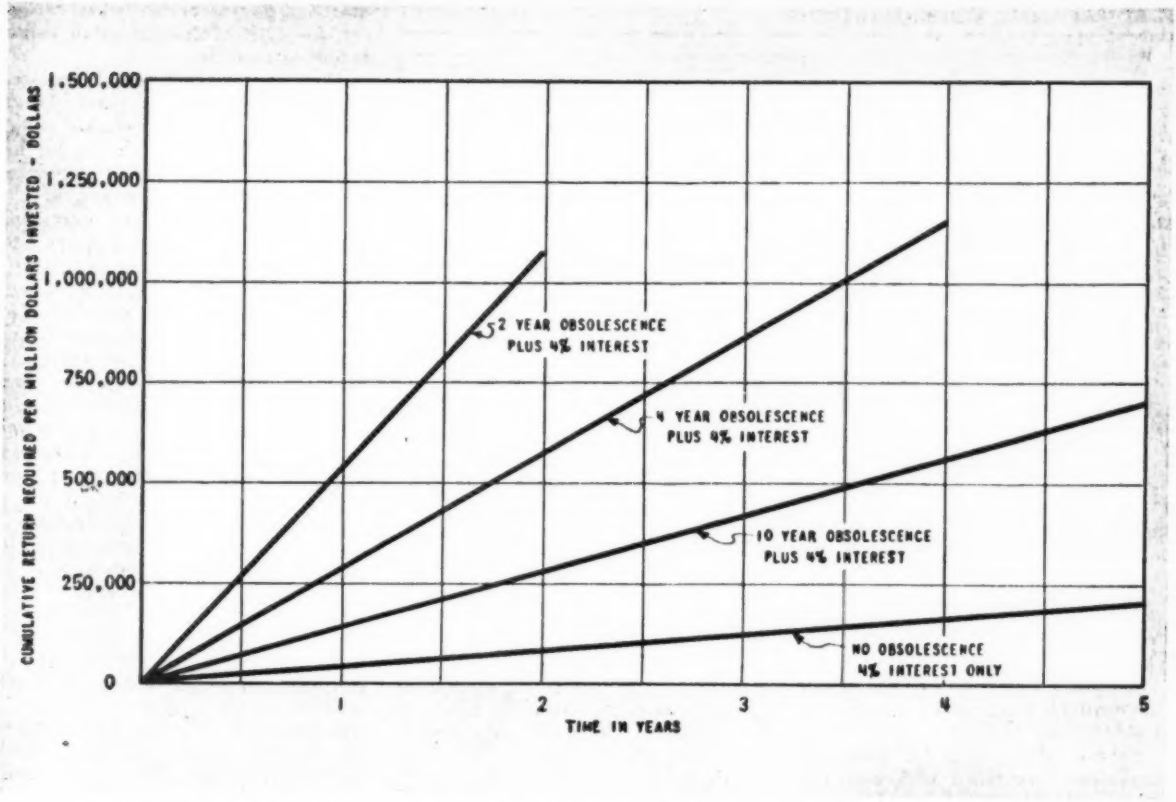

Figure 1. Required capital return for various periods of obsolescence (including 4 percent interest on initial investment).

For a petrochemical project . . .

These Capital Cost Considerations

Engineers spent much time developing designs for new plants for manufacturing modern products which they are sure the world is waiting for. Often these plants are not built, even though it is evident (1) the laboratory results demonstrated conclusively that the reactions were sound, (2) the pilot plant work demonstrated thoroughly the operability of the process and (3) the engineering was thorough and complete, thus assuring successful and continuous operation of the commercial plant to make product of required purity and form. Financial aspects of the plant installation pertaining to risk and competition with other projects are usually behind decision not to build.

Corporation tax level can have a direct effect on:

- Payout period
- Choice of competing processes

E. B. Chiswell and J. J. Merrill,
California Research Corporation, Richmond, Calif.

THE FINANCIAL considerations behind the management decision to install or not to install a plant have many aspects. An entire book would scarcely suffice to cover adequately so complicated a subject and, accordingly, only a few of these financial considerations can be covered here.

Allocation of the Money—Allocation of capital for plant construction may be decided on any one of three bases. The first, and most straightforward, is a consideration of the risk involved in the capital investment versus the return to be received from making this investment. This is the basis which would be used for a group which was considering only one plant as a possibility for installation.

In the second case, which frequently occurs in large companies with substantial research facilities, a number

Capital Cost Considerations . . .

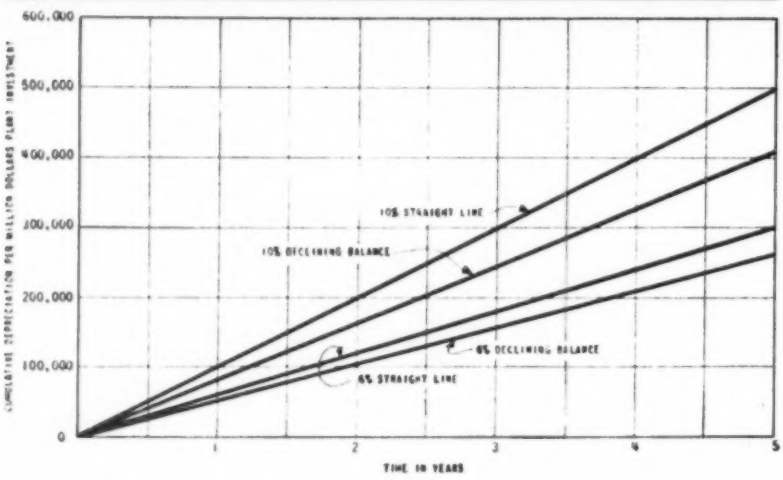

Figure 2. Comparison of declining balance and straight line methods of depreciation accounting.

of processes are available which might be installed with a fair return on the capital. In this case the processes become competitive with one another for the available funds which might be invested in new projects.

In the third category, plants are sometimes installed with somewhat less expected return because it is desirable to maintain the company's position in a field. The simplest requirement for installations of this type is an expansion of the market which calls for facilities to increase product volume. Quite often, competition requires that the quality of a product be improved, even though installation of facilities for improving quality may not show a high rate of return as an incremental investment.

Required Payout Period Varies—In order for an investment in new facilities to appear attractive, it is necessary that the profit from investment pay the interest on the funds invested as a cost plus a sufficient return to repay the capital expended. Many studies have been made of the payout period; that is, the number of years required to return the capital to the investor. The table published in *Business Week*, January 22, 1949, shows the payout periods required by a number of companies for new equipment in manufacturing industries. In the steel industry, 30 percent of the companies required a five-year payout or less. In the petroleum industry, 50 percent of the companies required a payout of five years or less. In the automobile industry, 29 percent of the companies required a payout of two years or less, 57 percent required a payout of three years or less, and 72 percent required a payout of five years or less. In the chemicals industry, 10 percent required a payout of two years or less, 20 percent a payout of three years or less, and 60 percent a payout of five years or less. In substantially all cases, the companies required a payout of ten years or less for any type of investment in manufacturing facilities.

These short payout periods required by management for new plants do not represent physical depreciation or deterioration of the plants to be installed. Probably the most important consideration is obsolescence of the plant or of the product therefrom. Modern engineering rarely makes mistakes of sufficient magnitude that prevent commercial plants from operating as designed. It is possible for management to make reasonably accurate estimates of the growth curve of the product which they are planning to manufacture, assuming relatively stable conditions of the economy surrounding this product. There is, however, no way for the manager or president to know whether or not a competitor has in his laboratories a process under development which will improve existing processes to such an extent as to render them obsolete. Of even more importance these days is the fact that he has no way of knowing whether or not a new product will be presented which will decrease the demand for his product to such an extent that he will either be unable to sell his plant product or find it necessary to reduce the selling price below the economic level.

The above considerations are aggravated by the fact that it usually takes from 18 to 24 months to build a plant and push it up to full production rate. Only then can we begin to return the capital invested at the projected rate; consequently, the period of high risk is seriously extended.

Another factor that requires investment in manufacturing facilities for some industries, such as the automobile industry, is the matter of style. The automobile industry expects styles will change and in many cases automobile manufacturers realize that they themselves will change the styles within one or two years making at least parts of the manufacturing facilities being installed obsolete. Fortunately this does not usually affect petrochemical plants except indirectly, as for example, the increased requirement for plastics in the fibre glass bodies of sports cars.

The manufacture of petrochemicals is a moderately high risk venture. The chief reason for this is the tremendous volume of research under way in the United States today and the possibilities of new products being discovered to replace those for which the plant is being built. These risks are increased by the relatively long construction periods required for petrochemical plants. Thus, it is quite common for management to require return of their

TABLE 1

Manufacture of Ethylene Oxide

Production Rate 30,000,000 Pounds Per Year

	Direct Oxidation	Chlorohydrin Process
Capital Investment Required[1]	$6,000,000	$3,000,000
Feed Ethylene at five cents per lb.	5.3 cents per lb. product (60 mole % yield)	3.7 cents per lb. product (85 mole % yield)
Operating Costs		
Catalyst and Chemicals	0.2 cents per lb. product (60 mole % yield)	8.2 cents per lb. product (85 mole % yield)
Variable Costs (Including Labor and Utilities)	1.5 " " " " " "	1.0 " " " " "
Fixed Costs (Maintenance, Interest, Insurance, Property Tax, etc.)	2.9 " " " " " "	1.5 " " " " " "
Amortization in four years at 50% Income tax rate after 10% per year depreciation	9.9	14.4
	8.0 " " " " " "	4.0 " " " " " "
Total Cost of Production	17.9 " " " " " "	18.4 " " " " " "

[1] Includes investment for process equipment, land, buildings, storage, associated utilities and miscellaneous

investment in two, three, or four years after plant completion.

Effect of Corporate Tax Level—A factor which vitally influences the rate of capital return, and which affects the engineer's ability to obtain management approval for plant construction, is the current corporate income tax rate. Taxes have become a very important consideration in our ability to recover our capital investment. At extremely high tax rates, there is a tendency for modern processes, which are generally more expensive for initial installation, to suffer in comparison with lower risk plants of established processes. At lower tax rates, more modern, more efficient plants could be installed, whereas with higher tax rates it is considerably more difficult to make advances. This has a dampening effect on activity which is connected with development of new and more efficient techniques for manufacturing products.

In considering the effect of taxes on the necessary return on investment, there is shown graphically in Figure 1 the cumulative return required for different periods of obsolescence (or elapsed time for capital recovery) without taxes. The bottom line shows the return necessary to recover interest (4 percent) on the plant investment and in this presentation is treated as part of the cost of the product manufactured. The slope of the upper line indicates the rate of earning necessary to recover the capital in two years. The other two lines show return required for capital recovery in four and ten years, respectively.

When thinking of taxes, the depreciation rate the government will allow as a deduction before taxes must be considered. Figure 2 shows the rate at which plants can be depreciated for straight line and declining balance depreciation. Most frequently companies use the straight line depreciation method for tax purposes. Normally, the highest rate which may be used for tax purposes is 10 percent per year. Although many plants must be depreciated at a lower rate, 10 percent has been used in order to avoid exaggerating unduly the effect of taxes on the required return for capital recovery.

Ethylene Oxide Example—Although the current tax level is in the range of 50 percent for most companies, higher and lower tax rates will be considered for the purpose of illustrating their effect. Figure 3 shows the net return for a four-year plant payout, including taxes and interest, required at different tax rates. It can be seen that for a 50 percent tax rate, the dollars return before taxes must be about 50 percent more than would be required without taxes. This may be considered as about the average that can be hoped for in considering investments in new plants. For those companies which have operated in the region of so-called excess profits where the tax rate was 80 percent or more, it became exceedingly difficult to recover the investment as required for a high risk venture. The amount of money which had to be taken in by the product was over twice that required with a tax rate of 50 percent.

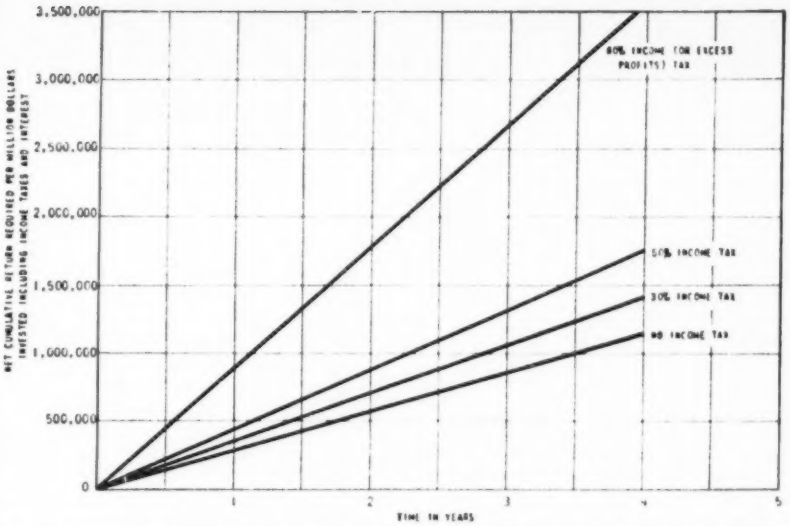

Figure 3. Effect of income tax on required capital return for four-year obsolescence. (Basis: 10 percent straight line depreciation allowed tax free per year.)

As a specific illustration, consider the manufacture of ethylene oxide. This product may be manufactured by the chlorohydrin process established some years ago or by direct oxidation of ethylene with air. Rough cost studies have been prepared which, are believed to be illustrative of the possible economics of manufacturing this product. These costs do not represent any particular process offered by any particular manufacturer. If any of the manufacturers feel that values shown are too high or too low, it is a simple matter to adjust the curves which fit different values.

It has been estimated that a plant for the manufacture of 30 million pounds a year of ethylene oxide by direct oxidation could be constructed for $6 million, whereas the plant to manufacture the same amount by chlorohydrin process would cost only $3 million. Table 1 shows the operating cost and raw material charges which might be required for each plant. Operating costs for the chlorohydrin process are 10.7 cents per pound of ethylene oxide whereas they are only 4.6 cents per pound for the direct oxidation route. Raw material costs are higher for the direct oxidation route; 5.3 cents per pound of ethylene oxide versus 3.7 cents per pound, if ethylene is charged to the processes at 5 cents a pound. Total costs before plant payout are 9.9 cents a pound for the direct oxidation route and 14.4 cents a pound for the chlorohydrin route. If we should have a situation in which the owner of the plant pays no taxes,

TABLE 2
Manufacture of Ethylene Oxide By Direct Oxidation

Production Rate Capital Investment Required[1]	30,000,000 Lb. Per Year[2] $6,000,000	45,000,000 Lb. Per Year $8,000,000
Feed Ethylene at five cent per lb.	5.3 cents per lb. of product	5.3 cents per lb. of product
Operating Costs:		
Catalyst and Chemicals	0.2 " " " "	0.2 " " " "
Variable Costs (Labor, Utilities, etc.)	1.5 " " " "	1.3 " " " "
Fixed Costs (Maintenance, etc.)	2.9 " " " "	2.5 " " " "
	9.9	9.3
Amortization in Four Years at 50% Income Tax Rate after 10% Per Year Depreciation	8.0 " " " "	7.1 " " " "
Total Cost of Production	17.9 " " " "	16.4 " " " "

[1] Includes investment for process equipment, land, buildings, storage, associated utilities, and miscellaneous.
[2] Repeated from Table 1.

Capital Cost Considerations . . .

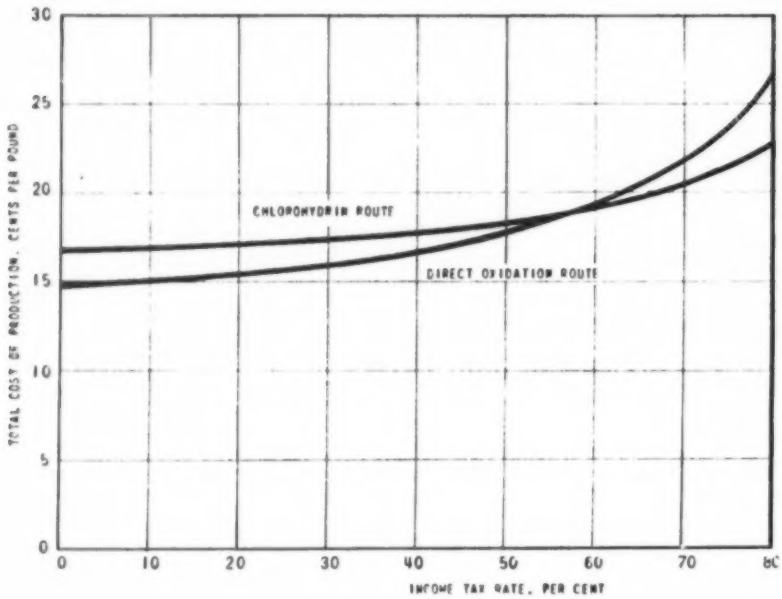

Figure 4. Total cost of producing ethylene oxide as affected by income tax rate. (Basis: return of investment in four years, 30 million pounds per year product, 10 percent depreciation allowance for tax purposes.)

the plant could be amortized in four years for 5 cents a pound ethylene oxide for the direct oxidation plant and it would take only 2½ cents a pound to amortize the chlorohydrin plant. Thus the total cost of ethylene oxide by the direct oxidation route is 2.0 cents a pound less than by the chlorohydrin route if a four-year payout is necessary.

If the tax rate is increased to 50 percent, the amount of money required for plant payout in four years is increased for the two processes to 8 and 4 cents, instead of 5 and 2½ cents a pound. Here the direct oxidation route is still cheaper than the chlorohydrin route, but by only 0.5 cents a pound of ethylene oxide. At this tax level, a producer might pause a long while before installing a direct oxidation route in preference to chlorohydrin process with this difference in price. He might consider it satisfactory to achieve a somewhat longer payout of the better established chlorohydrin process.

If the producer is required to pay very high taxes of say 80 percent, the cost of the product is reversed for the two processes. Money required for paying out the more expensive plant is 17 cents a pound of ethylene oxide versus 8.5 cents a pound for the chlorohydrin process. This results in a cost of ethylene oxide of 26.9 cents for the direct oxidation route and 22.9 cents for the chlorohydrin. These effects are illustrated over a wide range on Figure 4. It would be difficult under these circumstances to prove to management the desirability of installing a process which from the engineer's point of view is a marked improvement. Thus, even though a new plant may be efficient enough to pay for the high costs of installation before taxes, the high tax rates decrease the probability of being able to develop improvements that will be economically attractive.

Assume that the posted price for ethylene oxide in tanks is 19 cents a pound. For the 50 percent income tax situation, the indicated four year amortization would pertain but at the 80 percent income tax rate, the payout period would be extended to about six and a half years even for the chlorohydrin process.

Effect of Plant Size Another factor which influences product costs through required capital investment is plant size. Generally speaking, it is cheaper per unit of product to build a large plant than a small plant. The engineer becomes critically dependent on the product development man and the sales organization of his company at this stage of a project consideration. If all agree that the growth curve for the product is increasing at a satisfactory rate and that the company will get the required share of the total business, it may be possible to consider construction of a large size plant. Table 2 shows the cost of ethylene oxide produced by the direct oxidation route for two plants, one to produce 30,000,000 pounds a year of ethylene oxide, and the second to produce 45,000,000 pounds of ethylene oxide. For this table we have simply ratioed the cost of the plants on the 7/10 power of size and the operating cost has been appropriately adjusted downward. It is noted that at 50 percent income tax, ethylene oxide from the large plant costs about 1½ cents a pound less than from the smaller plant. This may seem at first glance to be a rather minor saving but it should be noted that the 1½ cents is incremental and represents either clear profit or ability to obtain a faster return of capital investment.

In the latter connection, there is almost certain to be a greater risk in building the larger plant, in that a greater share of the total market is required to absorb the product. Therefore, from the investment sandpoint, it may be necessary to offset the increased risk by requiring a more rapid return. If this should turn out to be three years, instead of four years as indicated, the cost of amortization would increase from 7.1 cents to 10.1 cents per pound of product. Thus, building larger plants is by no means a general solution to the problem. When thinking of a larger plant, management must be vigilant to assure that the advantage of size actually outweighs the increased risk.

It can readily be seen that items of taxation, plant complexity, and plant size all influence the number of dollars which must be brought in by a project in order that the capital invested in it may be returned in a reasonable time. All of these considerations do have one common denominator. It is simply this: In these days of more complicated and expensive plants, the incentive for inexpensive ingenious designs and engineering was never greater. This is a challenge to the engineering profession which it can accept. Lowered plant cost as determined by competent engineering represents a goal towards which the engineer has always worked with understanding and enthusiasm.

This paper was presented before the American Institute of Chemical Engineers in San Francisco in September, 1953.

Most comprehensive . . .

Equilibrium K's by Nomograph

Range includes the light hydrocarbons, narrow-cut petroleum fractions, and certain non-hydrocarbons from 40 to 800 F. at pressures up to 10,000 psi.

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Fractionation Research, Inc.,
Woodbury, N. J.

A CORRELATION of the vapor-liquid equilibria K ratios of the light hydrocarbons, narrow cut petroleum fractions and certain non-hydrocarbons is presented as a function of the temperature and pressure of the system and the composition of the liquid phase. It is applicable from 40 to 800 F. at pressures up to 10,000 psi. The arithmetic average deviation from experimental data is 6.8 percent.

General Vapor-Liquid Equilibria Relationship—The K value of a component in a system of hydrocarbons at a constant temperature is greater than unity at pressures below its vapor pressure at that temperature; and it is equal to unity at its vapor pressure and less than unity at higher pressures. As the pressure is increased, the K's of all except the most volatile component go through minimum values and then approach unity at some common pressure. If the system is at its critical temperature the K's of all components become equal to unity at the critical pressure of the system. At other temperatures the K's converge toward unity but do not reach unity because one phase disappears. At temperatures considerably below the critical temperature of the system the phases may unite even before the components go through the minimum K region; nevertheless, there is a tendency for the K's to take a path such as described. Thus, for any temperature there is a pressure, the convergence pressure, at which the K's are equal to unity or converge toward unity. Convergence pressure is a function of the temperature of the system and composition of the liquid phase. It is a useful parameter for correlation of vapor-liquid equilibria data.

The vapor-liquid equilibrium relationship is a complex function involving six variables: the K ratio, the individual components, temperature, pressure, convergence pressure and, in the case of the lighter hydrocarbons and non-hydrocarbons, the nature of the liquid phases. Figure 1 is a nomogram relating five of the variables. The sixth variable, convergence pressure, is accounted for by means of a coordinate plot used in conjunction with the nomogram.

K Values at 5000-pound Convergence Pressure—The nomograph consists of a temperature-pressure network, a K scale, and a component-solvent scale. The nomogram may be used directly to obtain K's of any component from ethane through heptane in a paraffin hydrocarbon system having a convergence pressure of 5000 pounds. The procedure is simply that of reading the K scale where it is crossed by a straight line passed through the desired component and a point on the pressure-temperature (P-T) network corresponding to the pressure and temperature of the system.

NOTATION

b = volatility exponent from Figure 4 to be used in Equation (1)
K = vapor-liquid equilibrium ratio = y/x, dimensionless
K_2 = vapor-liquid equilibrium ratio of ethane
K_7 = vapor-liquid equilibrium ratio of *n*-heptane
K_b = vapor-liquid equilibrium ratio of a pure component or of a petroleum fraction
P = system pressure, psia.
P_g = grid pressure from Figure 2, psia.
P_{cv} = convergence pressure, psia.
T = system temperature, °F.
w = weight fraction of a component in the liquid phase
x = mol fraction of a component in the liquid phase
y = mol fraction of a component in the vapor phase

K Values at Other Convergence Pressures—Figure 2 is a coordinate plot showing the relationship between system pressure, convergence pressure and "grid" pressure, the latter being used in conjunction with the nomogram to obtain K values at convergence pressures other than 5000 pounds. The procedure for using the nomogram at convergence pressures other than 5000 pounds for system pressures under 5000 pounds is as follows:

1. Locate the system pressure-temperature point, i.e., that point on the P-T network corresponding to the pressure and temperature of the system, and draw a straight line connecting this point to 1.0 on the K scale;

2. Locate and circle the point of intersection of this line with the pressure line corresponding to the grid pressure from Figure 2. This point is called the grid point to distinguish it from the system P-T point.

3. Read the K scale where it is crossed by a straight line passed through the grid point from Step 2 and the desired component.

For example, determine the K ratio of *n*-hexane at 650 psia and 100 F. in a system having a convergence pressure of 1300 psi. Figure 2 gives 900 pounds as the grid pressure. The system pres-

Equilibrium K's by Nomograph . . .

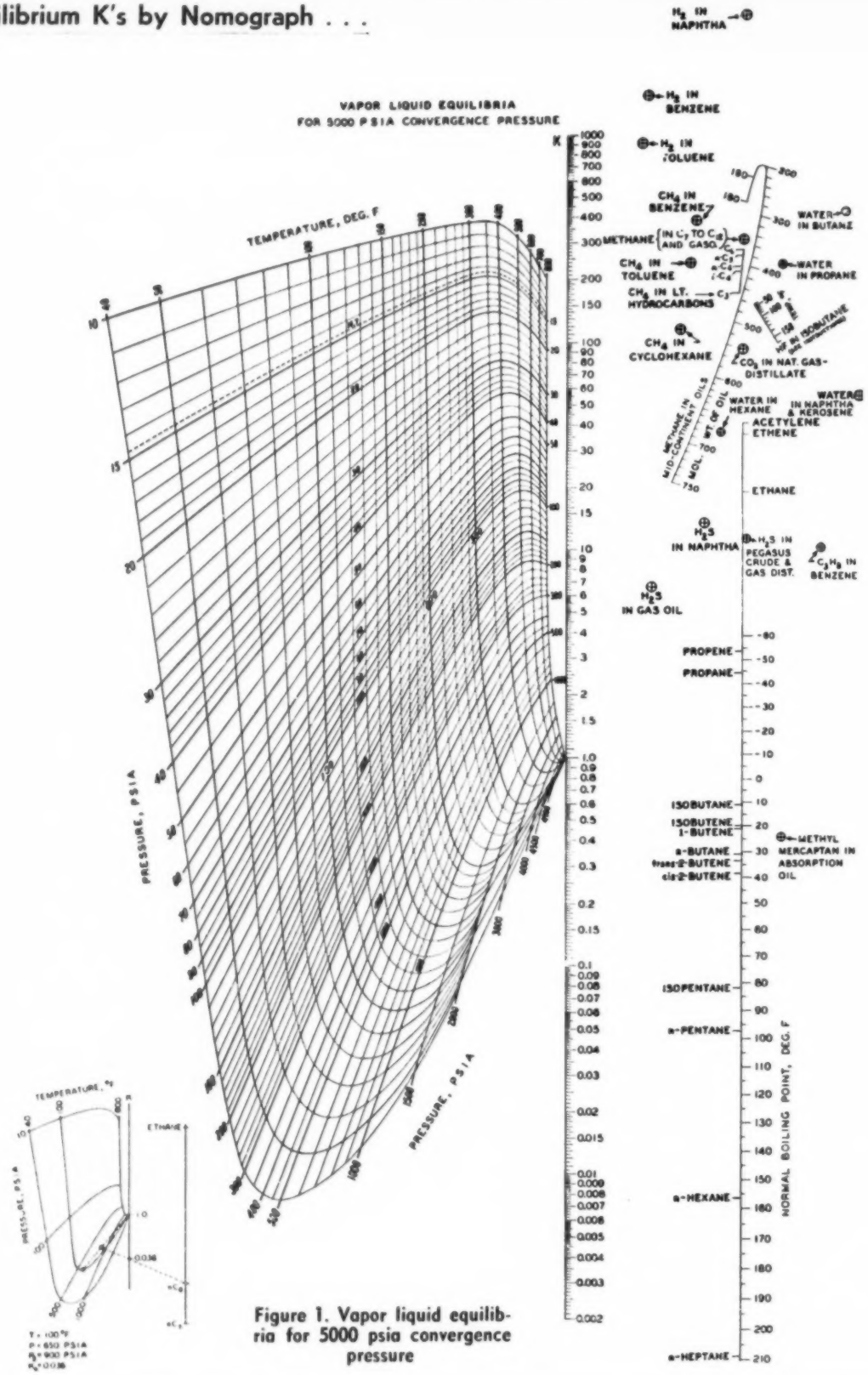


Figure 1. Vapor liquid equilibria for 5000 psia convergence pressure

sure-temperature point (P=650, T=100) is connected to 1.0 on the K scale with a straight line. The place where this line crosses the 900-pound pressure line, corresponding to 900-pound grid pressure, is circled or otherwise marked. The resulting point yields a K value of *n*-hexane of 0.036 as is illustrated by the insert on Figure 1. This same grid point would be used to determine the K's of all other components in the system, e.g., 1.2 and 0.0156 for ethane and heptane, respectively.

The procedure for using the nomogram for system pressures greater than 5000 pounds is as follows:

1. Locate a point on the P-T network corresponding to the system temperature and the *grid* pressure.

2. Read the K scale where it is crossed by a straight line passed through the point from Step 1 and the desired component.

For example, determine the K ratio of *n*-pentane at 6000 pounds pressure and 100 F. in a system having a convergence pressure of 10,000 pounds. Figure 2 gives 4600 pounds as the grid pressure. The point on the P-T network corresponding to 4600 pounds and 100 F. is circled. The K of n-pentane read from this point is 0.53.

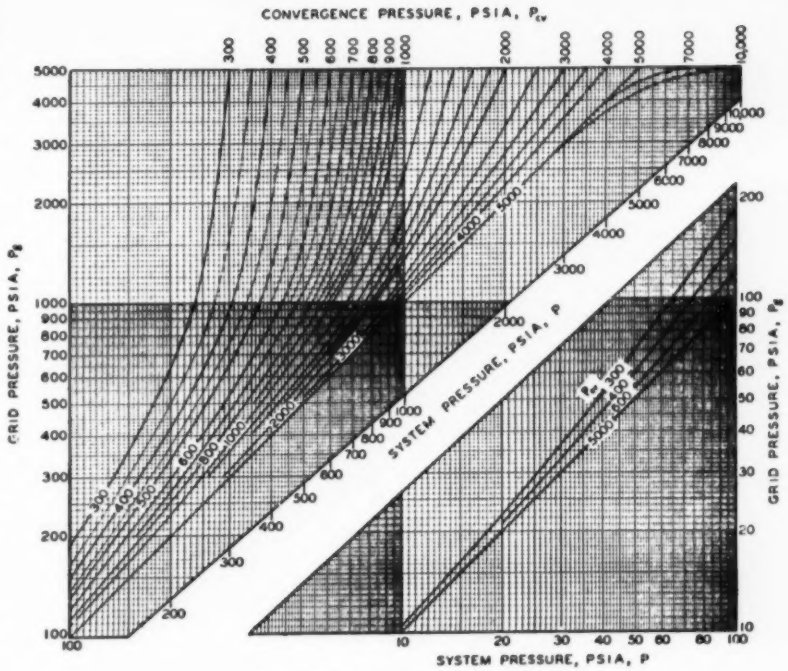

CONVERGENCE PRESSURE, PSIA, P_{cv}
GRID PRESSURE, PSIA, P_g
SYSTEM PRESSURE, PSIA, P
SYSTEM PRESSURE, PSIA, P
GRID PRESSURE, PSIA, P_g

Figure 2. Grid pressure relationship.

Character of the Liquid Phase—At a constant system pressure and temperature, the K of methane varies widely between solvents of different physical properties even though the convergence pressure is the same for all of the systems. Ethane and heavier hydrocarbons also vary but to a lesser extent. The K ratios of hydrogen and other non-hydrocarbons also are strongly affected by the solvent.

The pressure-temperature network and the K scale of the nomogram may be used in conjunction with experimental data to establish component points for methane or hydrogen in a particular solvent. However, instead of obtaining one position as for butane and heavier components, a different position is obtained for each different solvent as is shown in the upper right hand part of Figure 1.

There is a similarity in the location of these points for the various components in a given solvent. For example, the respective points for hydrogen and methane in benzene are in the same relative position as hydrogen and methane in toluene. Similarly, methane and hydrogen sulfide in heavy oils bear a resemblance to each other. As the nomogram now stands there is no quantitative method of finding a component position to be used for methane, hydrogen, etc., excepting for the specific solvents which are indicated.

The component position point for non-hydrocarbons other than those indicated on the nomogram cannot be estimated satisfactorily. However, the nomogram serves a useful purpose in this regard: if data are available at a few temperatures and pressures, temporary construction lines through the K scale and points on the P-T grid may be used to find the component position point from which K values at other temperatures and pressures may be estimated with good accuracy. Low-pressure data are especially useful for this purpose because at low pressure the effect of convergence pressure is negligible, hence the data may be used directly on the nomogram.

Methane K. Solvent position points are shown for methane in toluene, benzene, cyclohexane, light hydrocarbons, gasoline and Mid-Continent oils. For methane in equilibrium with light hydrocarbons the solvent position point is on the line of CH_4-in-light-hydrocarbons located in accordance with the weight average boiling point of the liquid phase exclusive of methane. A point along the line of CH_4-in-Mid-Continent-oils, positioned at the molecular weight of the oil, may be used for methane in equilibrium with absorber oil, gas oils or crude oils having a U.O.P. characterization factor of 11.8.

Hydrogen. At present there is no reliable method for predicting the convergence pressure of hydrogen systems. Indications are that the convergence pressure of such systems at moderate temperatures far exceeds 10,000 psia, the maximum at which the correlation is presently applicable. However, at pressures under 200 pounds the nomogram can be used directly with good results. Between 200 and 1000 pounds the deviation from experimental data is as much as 50 percent. The correlation may result in errors of 100 percent above 1000 pounds.

Hydrogen component position points for the solvents, toluene, benzene and naphtha, are indicated on the nomogram. The relationship for methane may be used as a guide to approximate a component position point for solvents not indicated on the nomogram.

Hydrogen Fluoride. The component position for HF in isobutane is indicated by a short line graduated with the temperature of the system. The nomogram is applicable to this system from 40 to 160 F. and up to 200 pounds pressure with a standard deviation of 3 percent based on a comparison of 15 points. This method of plotting the component position for HF was chosen because it may be used without consideration of convergence pressure, i.e., the nomogram may be used directly. It is applicable under conditions where two liquid phases and one vapor phase coexist or where the hydrocarbon rich liquid phase and the vapor phase coexist. The K of HF is the ratio of its molal concentration in the vapor phase to its molal concentration in the hydrocarbon rich liquid phase.

Carbon Dioxide. The component position point for carbon dioxide in a natural gas-distillate condensate is indicated. The convergence pressure of this system was very near 5000 psia at all temperatures.

Hydrogen Sulfide. Component position points for H_2S in a gas oil and naphtha and Pegasus crude and a natural gas distillate are indicated on the nomo-

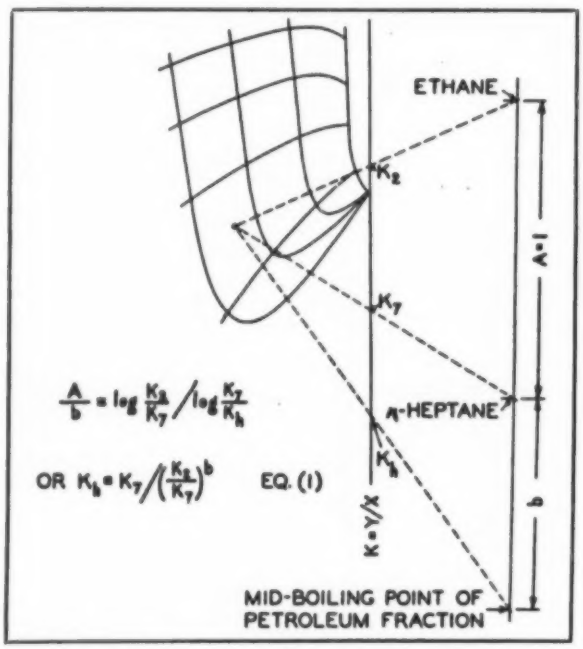


Figure 3. Graphical construction showing derivation of Equation (1).

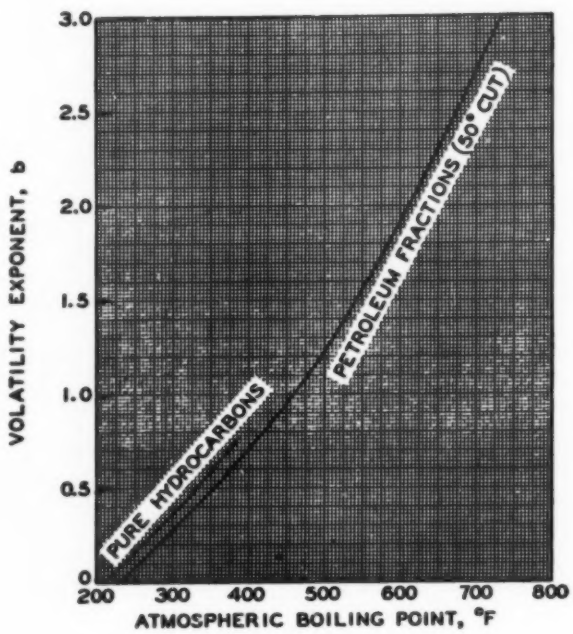


Figure 4. Volatility exponent.

gram. The data used to find the naphtha and gas oil points were at room temperature and at pressures from 50 to 200 psia. Those for the Pegasus crude and natural gas distillate were from 40 to 250 F. and 50 to 4000 psia. The convergence pressure used to establish these points was 5000 psia.

Methyl Mercaptan. A point for methyl mercaptan in a 195 mol. wt. absorption oil is located on the nomogram. The temperatures used to establish the point were from 65 to 79 F. and the pressures were from 67 to 605 psia.

Water. Component position points for water in propane, butane, hexane and a naphtha are indicated on the nomogram. The convergence pressure to be used for these water systems is the critical pressure of the hydrocarbon plus the vapor pressure of water at the critical temperature of the hydrocarbon. As with the HF-isobutane system, it is applicable under conditions where the hydrocarbon rich liquid phase exists either with or without the other liquid phase.

K Ratio of Light Hydrocarbons Not Identified by Name—It is impractical to show on the nomogram all of the hydrocarbons with boiling points between those of propane and heptane. However, the component scale is graduated with the normal boiling point of the hydrocarbons and it may be used to locate a point from which a K value may be obtained in the same manner as components which are identified by name. The K of benzene in the propane-benzene system determined in this manner (from a point on the component scale at its normal boiling point of 176 F.), gave a standard deviation of 7.2 percent from experimental values.

K Ratio of Narrow Cut Petroleum Fractions—In a great number of calculations involving the use of K's, components having the same number of carbon atoms can be grouped and considered as a single component with only a small sacrifice in accuracy of the results. The molal average boiling point may be used to identify such mixtures and K values may be determined from the right side of the component scale.

K Ratio of Pure Components and Petroleum Fractions Boiling Above 210 F.—The component scale is not extended into the region where the boiling point exceeds 210 F. because such an extension would cause an undersirable compression of the K scale. It would be possible to construct a separate nomogram for this region but the time required to do so has not been available. However, the same basic correlation which applies to the light hydrocarbons also applies to the higher boiling pure compounds and petroleum fractions and a relation has been found for using the nomogram to obtain their K's.

A schematic diagram of the nomogram with the component scale extended into the high boiling region is presented in Figure 3. It is relatively easy from this diagram to derive the following equation:

$$K_h = K_7 \Big/ \left(\frac{K_2}{K_7}\right)^b \qquad (1)$$

where K_h = K value of the petroleum fraction or high boiling compound.
K_2 = K value of ethane at the temperature, pressure and convergence pressure of the system.
K_7 = K value of *n*-heptane at the temperature, pressure and convergence pressure of the system.
b = volatility exponent from Figure 4.

Ethane and heptane have been arbitrarily selected as the base components for this purpose, although any other pair of points along the component scale could have been used equally well. The volatility exponent is shown in Figure 4 plotted against the normal boiling point of pure hydrocarbons or against the mid-boiling point of petroleum fractions.

The procedure for obtaining the K of a pure compound or of a petroleum fraction having a mid-boiling point above 210 F. is as follows:

1. Determine the K values of ethane and heptane at the temperature, pressure, and convergence pressure of the system in accordance with the procedure described for light hydrocarbons.
2. Determine the volatility exponent

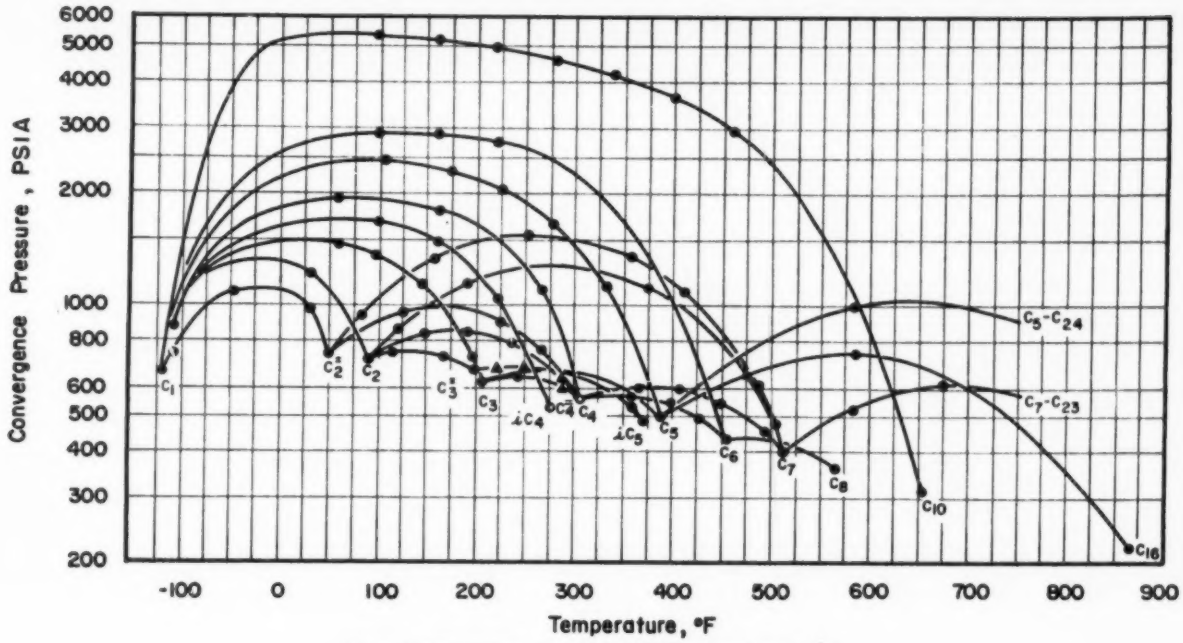


Figure 5. Convergence pressure of binary hydrocarbon systems.

of the pure component or the petroleum fraction from Figure 4.

3. Solve equation (1) for K_b, the K value of the pure compound or petroleum fraction.

For example, determine the K of *n*-decane at 650 psia and 100 F. in a system having a convergence pressure of 1300 psia. The K's of ethane and *n*-heptane determined for this same set of conditions by the procedure previously described are 1.2 and 0.0156 respectively. The volatility exponent, b, corresponding to the boiling point of *n*-decane of 345 F. is determined from Figure 4 to be 0.56. Then

$$K_{10} = K_7 \Big/ \left(\frac{K_2}{K_7}\right)^b = 0.0156 \Big/ \left(\frac{1.2}{0.0156}\right)^{0.56} = 0.00137$$

Equilibrium Ratios at Sub-Atmospheric Pressure—Sub-atmospheric values of the equilibrium ratio for pure compounds and petroleum fractions may be obtained by dividing the value at one atmosphere and the specified temperature by the absolute pressure in atmospheres. Convergence pressure does not have an appreciable effect on the K values at such pressures.

Convergence Pressure—For temperatures *below* the critical temperature of the lightest component, use the critical pressure of the lightest component as the convergence pressure. For temperatures *above* the critical temperature of the lightest component, as is the case for most commercial applications, the procedures given in the following paragraphs should be used.

Binary Systems with Methane as the Lightest Component. Refer to the critical locus curve in Figure 5 which connects the two components. Read the convergence pressure corresponding to the temperature of the system.

Other Binary Systems. Prepare a plot of the critical locus either from published experimental data or by calculation and proceed as above. Figure 5 shows a few curves for components other than methane.

Ternary Systems. Refer to the critical loci curves of the binary systems and at the temperature of the system read the pressures of the two critical loci curves connecting the lightest component to the intermediate and heavy components. If the system temperature is above the critical temperature of the intermediate component read the critical pressure of that component. Multiply these two pressures by the respective weight fractions of the intermediate and heavy components in the liquid phase, add the results, and divide by the sum of the weight fractions of the intermediate and heavy components in the liquid base.

Multicomponent Systems. Follow a procedure similar to that given for ternary systems, i.e.,

$$P_{cv} = \frac{(P_{cv})_2 W_2 + (P_{cv})_3 W_3 + \ldots}{W_2 + W_3 + \ldots}$$

where: P_{cv} = the convergence pressure of the system, psia.

$(P_{cv})_1$ = the pressure on the critical locus curve of the lightest component and the component identified by subscript at the temperature of the system, or it is the critical pressure of the subscript component if the system temperature exceeds the critical temperature of the subscript component.

W_1 = the weight fraction in the liquid phase of the component identified by the subscript.

Subscript 1, 2, 3 . . . identifies the components, 1 being the lightest, 2 the next heavier, etc.

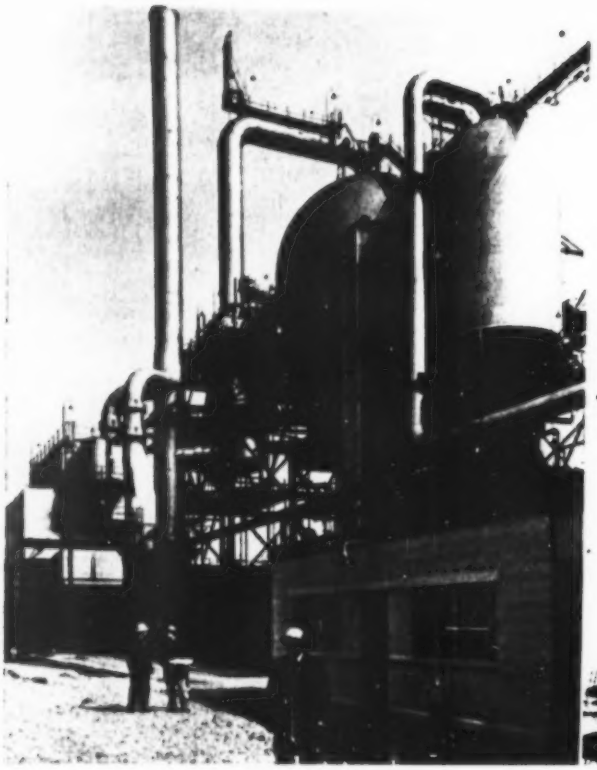
Complex Systems. Compute the true critical temperature and pressure of the hexane plus fraction. The method described by Edmister is very convenient for this purpose. Plot this point and sketch in the critical locus curve to the lightest component using adjacent curves as guides, or if desired calculate the critical locus. Treat as a multicomponent system with C_6+ considered as the heaviest component.

Hydrogen Containing Systems. The effect of hydrogen on convergence pressure has not been investigated extensively. However, it is known that a system with hydrogen as the lightest component will have a much higher convergence pressure than the same system with methane as the lightest component. Tentatively, it is suggested that the convergence pressure of hydrogen systems be taken as 10,000 psia.

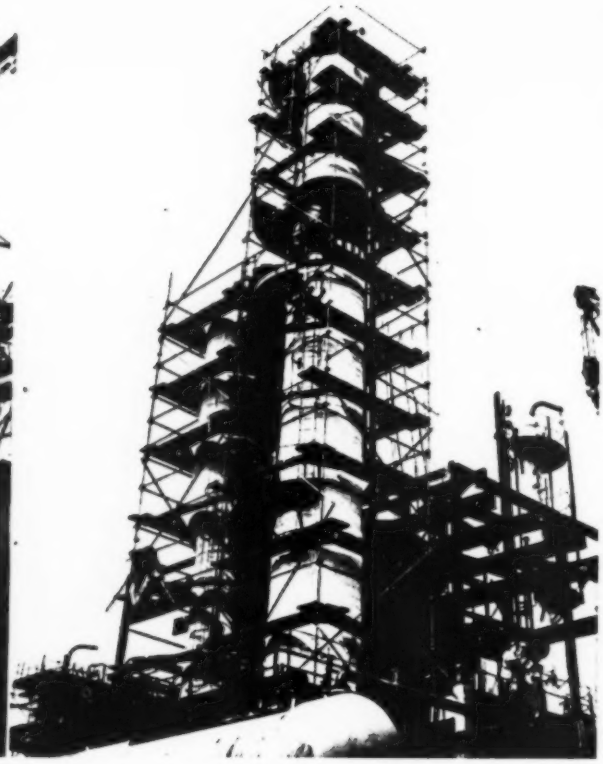
ACKNOWLEDGMENT

This article is a condensed and modified version of "Simplication Nomographic Presentation of Hydrocarbon Vapor-Liquid Equilibria," published in Chemical Engineering Progress Symposium Series No. 2, Vol. 48. The reader is referred to the original article for the development of the correlation, comparisons with experimental data, and references.

The author gratefully acknowledges the capable and diligent assistance of S. T. Kiguchi in completing and checking the final correlation. S. T. Hadden assisted materially by his suggestions and by providing in a convenient form a large amount of experimental data obtained from the literature over a period of years. The constructive criticism and suggestions of L. R. Steffens were helpful. Permission of Socony-Vacuum Oil Company, Inc., to publish this paper is acknowledged.



World's biggest cat cracker: 63,750 barrels per day capacity



Cat poly unit at Philadelphia plant: 2800 barrels per day capacity

Gulf's Plant Largest on East Coast

COMPLETION of a $50 million expansion program which now makes Gulf Oil's Philadelphia refinery the largest on the East Coast was announced last month.

Among the new units which have been added to the refinery are two of the largest ever built. Completion of these, along with other equipment, increases the refinery's capacity by 75 percent and gives the plant a total thruput of 133,000 barrels a day.

World's Biggest "Cat"—The first of the new units finished was the world's largest fluid catalytic cracker. This refining giant, with a capacity of 63,750 barrels a day, is slightly larger than Gulf's other big "cat" at the Port Arthur, Texas refinery which has been in operation two and a half years.

World's Biggest Still—Another of the new units is a 125,000-barrel-a-day atmospheric and vacuum still which is the largest of its kind ever built. The new still is more than 15 times larger than the first distillation unit built at the Philadelphia plant in 1927.

The new atmospheric and vacuum still, constructed by the Foster Wheeler Company, will make gasoline, heating oils, charge stock (gas oil) for the catalytic cracking units and residual oil. It has one of the largest furnaces ever built for refining equipment. This furnace covers 3000 square feet and will consume 2000 barrels fuel oil daily.

New Catalytic Polymerization Unit—Another new unit is the catalytic polymerization equipment, which further refines the propylenes produced by the "cat" cracker. This unit will produce 2800 barrels per day poly gasoline.

In addition to the new major units, a good deal of auxiliary equipment has been necessarily added to bring the total storage capacity to an excess of 11 million barrels. A new tank farm has been built across from the refinery on the Schuylkill River with total capacity of 2.3 million barrels of storage, and a large addition has been made to the Darby Creek crude oil tank farm, about five miles distant, which gives it a total storage capacity of 2.9 million barrels. Altogether, more than 30 miles of pipe line have been installed in connection with the recent expansion.

The program has been rounded out by the construction of two ultramodern buildings; one for the administrative personnel of the refinery, the other for the Refinery Technology Laboratory.

How to predict . . .

True Volumes in Blending

Chart on next page will give blending value of the lighter compound in a mixture of petroleum fractions.

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PREDICTION OF the true volume of a blend is important to the refiner and natural gasoline manufacturer since small changes can have considerable economic significance when products are measured in thousands of barrels. Several investigators have presented charts and equations for estimating these volumetric contractions. Most were limited to systems where small quantities of light material are blended with a heavier oil or where the fractions have approximately the same molecular weight.

Blends of petroleum fractions are usually assumed to be "ideal solutions" where no changes in volume occur. Numerous investigators have shown, however, that these mixtures are not "ideal solutions" and that for many blends a slight decrease in total volume can be expected. Thiele and Kay[2] reported a contraction of 0.25 volume percent when blending light and heavy naphtha. Van Der Vet[3] found a decrease in total volume of 0.2 percent for blends of propane and butane. Ioffe[2] showed contractions of 0.30 percent for petroleum ether and kerosine mixtures, 0.64 percent for petroleum ether and vaseline oil and 0.11 percent for gasoline and kerosine. Other literature data indicate much larger volume changes for blends of light fractions, such as ethane, propane and butane, with the heavier petroleum components.

A chart[2] has been prepared for predicting the blending value of the lighter compound in a mixture of petroleum fractions. Blending value was defined as the ratio of the partial specific volume to the actual specific volume or the apparent volume of this component. This blending value can be used when the mixture contains 15 percent or less of the lighter component.

Biron[1] proposed the following relation for calculating the change in molecular volumes (ΔV) for hydrocarbon mixtures.

$$\Delta V = K N_1 N_2 \qquad (1)$$

N_1 and N_2 are molecular fractions of the components and K is an experimental constant. This equation is valid for hydrocarbon systems where the molecular weights of the components are approximately equal. When the molecular weight ratio is greater than 1.5, K varies widely and is a function of the composition of the mixture.

TABLE 1
Values of K_p for Various Hydrocarbon Mixtures at 20 C.[2]

SYSTEM	$K_p \times 10$
iso-pentane-hexane	0.73
iso-pentane-pseudocumene	3.67
benzene-toluene	0.40
benzene-ethylbenzene	0.52
benzene-p-pseudocumene	1.84
benzene-cyclohexane	1.05
benzene-hexane	1.85
benzene-2,2,4-trimethylpentane	2.26
benzene-hexadecane	3.77
benzene-petroleum ether	1.55
benzene-fraction of Groznui petroleum, 75-85 C	2.11
benzene-turpentine @ 22 C	2.07
benzene-vaseline oil	2.51
cyclohexene-cyclohexane	0.50
cyclohexane-cyclohexylbenzene	0.19
hexane-isohexane	0
petroleum ether-kerosine	1.77
petroleum ether-vaseline oil	3.96
toluene-methylcyclohexane	2.41
toluene-ethylbenzene	0.08
toluene-pseudocumene	0.45
gasoline-kerosine	0.58
ethylbenzene-pseudocumene	0.49
2,2,4-trimethylpentane-cumene	0.63
2,2,4-trimethylpentane-mesitylene	0.80
sec-butylbenzene-sec-butylcyclohexane	0.55
sec-butylbenzene-diisoamyl	0.27

TABLE 2
Values of β for Petroleum Fractions

Petroleum Fraction	Molecular Weight	β
Ethane	28	3.67
Propane	44	3.81
Butane	58	3.83
Petroleum Ether	87	3.62
Gasoline	104	3.50
	>100	3.50

Ioffe[2] presented a similar equation for predicting the specific volume changes (Δv) in systems of petroleum fractions. This relation is

$$\Delta v = K_p P_1 P_2 \qquad (2)$$

where P_1 and P_2 are weight percentages of the components and K_p is an experimental constant. The constant K_p varies less with composition than K and equation 2 is more satisfactory for calculating volume changes in petroleum fractions than equation 1. The values of K_p determined by Ioffe for various systems are shown in Table 1. When blending light materials, such as ethane, propane or butane with heavier petroleum fractions, K_p varies considerably with composition.

Apparently no simple relation exists between volume changes and chemical or physical properties. On mixing aromatic hydrocarbons with nonaromatic hydrocarbons, or petroleum fractions, expansion is often observed but, in some instances, contraction takes place. The expansion on mixing aromatic hydrocarbons with naphthenic hydrocarbons is greater than on mixing with paraffins. With petroleum fractions a contraction is observed and is greatest for mixtures of fractions with widely different molecular weights. The contraction is greatest when low molecular weight fractions, such as propane or butane, are used. Typical relations between volume con-

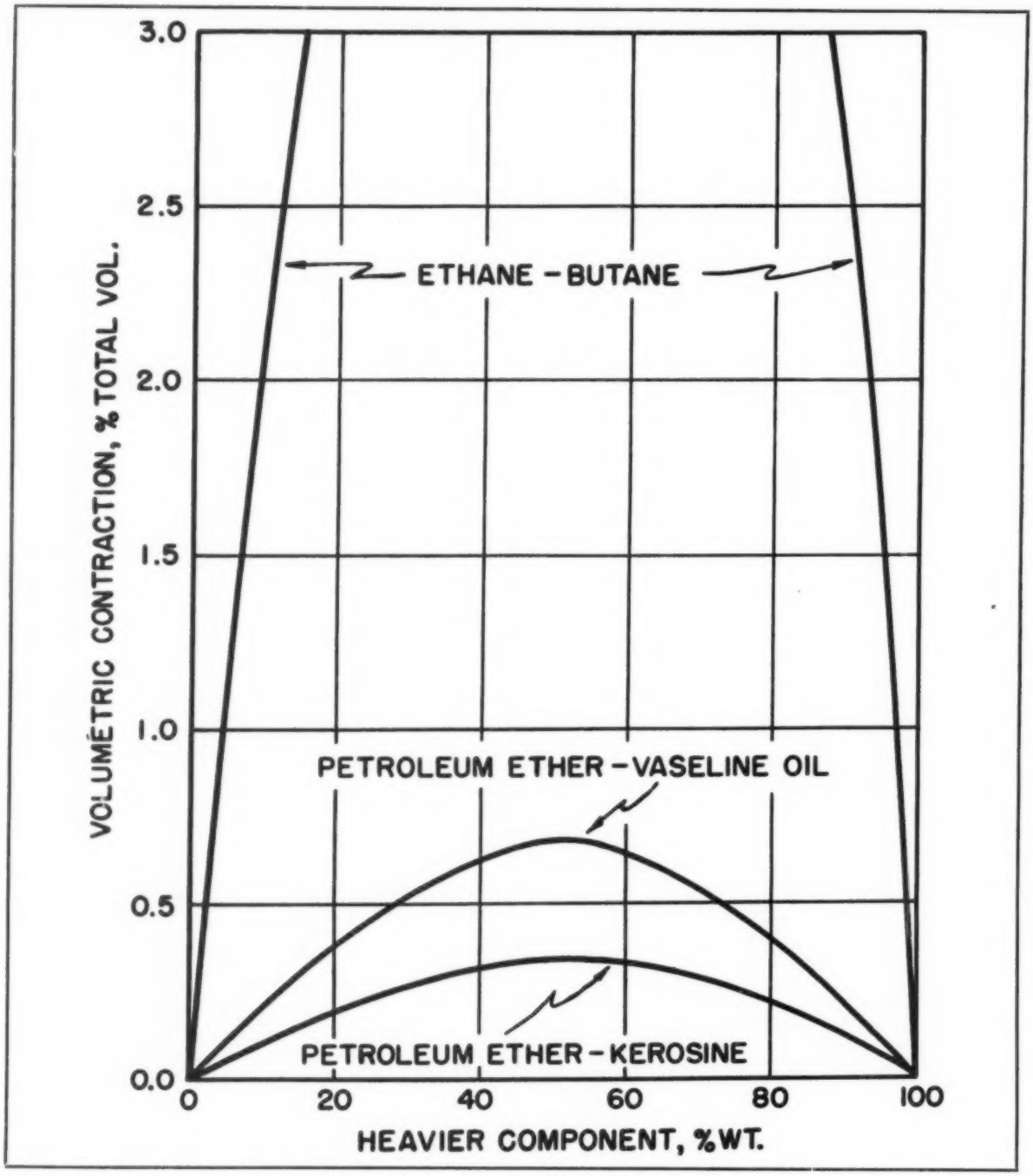

Figure 1. Typical volumetric contractions for petroleum fractions.

tractions and composition for several petroleum systems are illustrated in Figure 1.

Because of the complexity of these volumetric relations empirical equations developed by statistical analysis of available data are more useful for engineering calculations than the above theoretical expressions. Inspection of the curve in Figure 1 indicates that the volume change is a function of the composition and the molecular weights of the components. Accordingly, it was assumed that the volumetric contraction could be expressed by the following empirical relation:

$$\log C = \alpha \log P + \beta \log M_1 + \gamma \log (M_2 - M_1) + K \quad (3)$$

where C is the volume percent contraction, P is the weight percent of high molecular weight fraction in the blend, M_1 is the molecular weight of the lighter component and M_2 the molecular weight of the heavier component. α, β, γ and K are experimental constants. Volumetric changes in seven different blends of petroleum fractions at 60-70 F. with a total of 44 experimental points were used to determine the values of the constants in Equation 3. These blends have been reported in the literature and are enumerated below.

Ethane	— butane
Ethane	— heptane
Propane	— butane
Butane	— crystal oil
Gasoline	— kerosine
Petroleum ether	— vaseline oil
Petroleum ether	— kerosine

The data were analyzed by the method of least squares where it is assumed that the relation is a straight line equation with a minimum deviation between the experimental points and the function. The derived equation is shown below.

$$\log C = 0.6107 \log P + \beta \log M_1 + 0.537 \log (M_2 - M_1) + 4.418 \quad (4)$$

Equation (4) is valid for concentrations (P) of 50 percent or less of the heavier component. For concentrations of 50 percent and above the relation becomes

$$\log C = 0.6107 \log (100\text{-}P) + \beta \log M_1 + 0.537 \log (M_2 - M_1) + 4.418 \quad (5)$$

The number β, which is the exponent of M_1, appears to be a complex function of the molecular weight of the lighter hydrocarbon in the blend. Beta becomes a larger negative number as the molecular weight of the fraction increases and goes through a minimum point (largest negative number) at a molecular weight corresponding to butane. With fractions heavier than butane the value of β increases. For materials with molecular weights of 100 or more it is constant at —3.5. Values of β for various petroleum fractions are given in Table 2.

Equations (4) and (5) can be used for engineering estimations of the volume changes encountered in blending petroleum fractions at temperatures of 60-70 F. A comparison of the observed and calculated values for the various systems is given in Tables 3-9. Difference between the calculated and observed volumetric contraction is about 20 percent. For gasoline-kerosine blends (Table 7) the error is much greater and the calculated contractions are about 2 to 2½ times the observed values. However, the experimental data reported by Ioffe might not be accurate. Thiele and Kay's studies with light and heavy naphtha blends, which are similar to the gasoline-kerosine system, agree with the data calculated by the above equations.

The empirical equations presented here have been developed from the small amount of experimental data available in the literature. Insufficient data preclude the precise determination of some important variables and their effect on the systems. The variation of β with the molecular weight of the lighter hydrocarbon indicates that two distinct systems may be involved in blending of petroleum fractions. Different relations may exist for systems containing fractions heavier than butane and for those with components lighter than butane. The volumetric contraction is also affected by the aromaticity and structure of the fraction. These factors can only be resolved by a systematic investigation of numerous blends. Future work should be designed to clarify these variables and to develop more precise empirical relations for use by the industry.

Original presentation of this material was before the 9th Southwest Regional meeting of ACS, December, 1953, New Orleans.

ACKNOWLEDGMENT

The writer would like to express his appreciation to the Magnolia Petroleum Company for permission to publish this material.

TABLE 3

Calculated and Observed Contractions for Ethane-Butane Blends[4] at 70 F.

Composition of Blend, Percent Wt.		Volume Contraction, Percent Total Volume	
Ethane	Butane	Observed	Calculated
90	10		
80	20	3.76	3.62
70	30	5.67	4.64
60	40	7.22	5.53
50	50	7.86	6.33
40	60	7.41	5.53
30	70	6.02	4.64
20	80	4.62	3.62
10	90	2.70	2.38

TABLE 4

Calculated and Observed Contractions for Ethane-Heptane Blends[2] at 70 F.

Composition of Blend, Percent Wt.		Volume Contraction, Percent Total Volume	
Ethane	Butane	Observed	Calculated
90	10	3.51	3.89
80	20	6.28	5.93
70	30	7.53	7.43
60	40	7.44	9.06
50	50	8.63	10.4
40	60	7.96	9.06
30	70	7.03	7.43
20	80	4.86	5.93
10	90	2.73	3.89

TABLE 7

Calculated and Observed Contractions for Gasoline-Kerosine Blends[2] at 68 F.

Composition of Blend, Percent Wt.		Volume Contraction, Percent Total Volume	
Gasoline	Kerosine	Observed	Calculated
81.24	18.76	0.075	0.16
59.28	40.72	0.10	0.25
40.49	59.50	0.11	0.25
20.02	79.98	0.072	0.16

TABLE 5

Calculated and Observed Contractions for Propane-Butane Blends[5] at 60 F.

Composition of Blend, Percent Wt.		Volume Contraction, Percent Total Volume	
Propane	Butane	Observed	Calculated
90	10		
80	20	0.31	0.38
70	30	0.42	0.48
60	40	0.59	0.58
50	50	0.81	0.66
40	60	0.82	0.58
30	70	0.66	0.48
20	80	0.42	0.38
10	90	0.23	0.25

TABLE 8

Calculated and Observed Contractions for Petroleum Ether-Vaseline Oil Blends[7] at 68 F.

Composition of Blend, Percent Wt.		Volume Contraction, Percent Total Volume	
Petroleum Ether	Vaseline Oil	Observed	Calculated
79.96	20.04	0.38	0.39
57.37	42.63	0.63	0.62
41.75	58.25	0.64	0.61
21.45	78.55	0.48	0.41

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TABLE 6

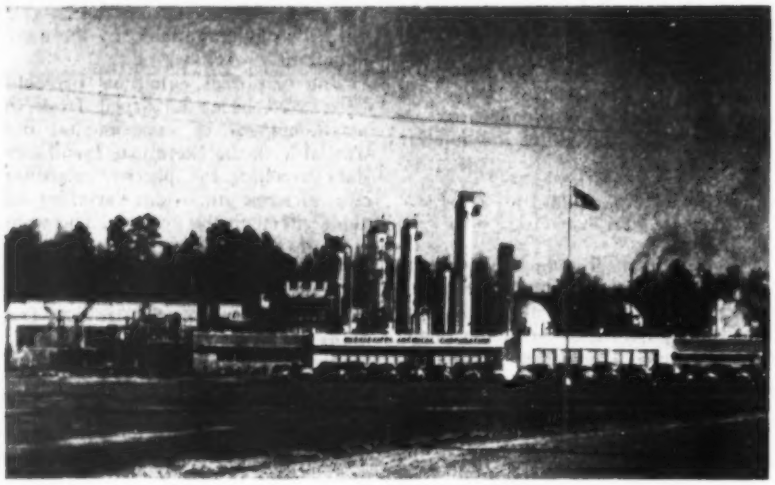
Calculated and Observed Contractions for Butane-Crystal Oil Blends[6] at 70 F.

Composition of Blend, Percent Wt.		Volume Contraction, Percent Total Volume	
Butane	Crystal Oil	Observed	Calculated
90	10	...	...
80	20	0.58	0.63
70	30	0.60	0.80
60	40	0.86	0.96
50	50	1.09	1.10
40	60	0.91	0.96
30	70	0.71	0.80
20	80	0.50	0.63
10	90	...	...

TABLE 9

Calculated and Observed Contractions for Petroleum Ether-Kerosine Blends[2] at 68 F.

Composition of Blend, Percent Wt.		Volume Contraction, Percent Total Volume	
Petroleum Ether	Kerosine	Observed	Calculated
71.56	28.44	0.25	0.25
59.33	40.67	0.30	0.31
39.75	60.25	0.33	0.30
21.71	78.29	0.25	0.21



Yazoo City plant: Now up to 180 tons per day ammonia.

More Ammonia for MCC

Mississippi Chemical completes one phase of its expansion to a 290-ton-per-day ultimate capacity.

MISSISSIPPI Chemical Corporation completed one phase of their expansion program when they put into operation 60 additional tons per day of ammonia capacity. Within one week from the date the plant was purged for startup preparations, the unit was producing in excess of its rated capacity, which brings MCC's ammonia production facilities to more than 180 tons per day.

The Mississippi Chemical Corporation process for gas reforming consists of a single-stage reformer operating at 15 pounds outlet pressure followed by CO conversion and MEA scrubbing for CO_2 removal. The gas is then compressed to 1000 atmospheres prior to high pressure methanation and ammonia synthesis using the Claude ammonia synthesis process.

A continuation of MCC's ammonia expansion program for this year consists of constructing a low pressure methanation unit which will remove all the carbon monoxide prior to compression. This will result in additional compressor capacity as well as free the present high pressure methanator for use as an ammonia converter. This step will be followed by additional reforming capacity and compression which will ultimately bring MCC's total capacity up to in the neighborhood of 290 tons per day.

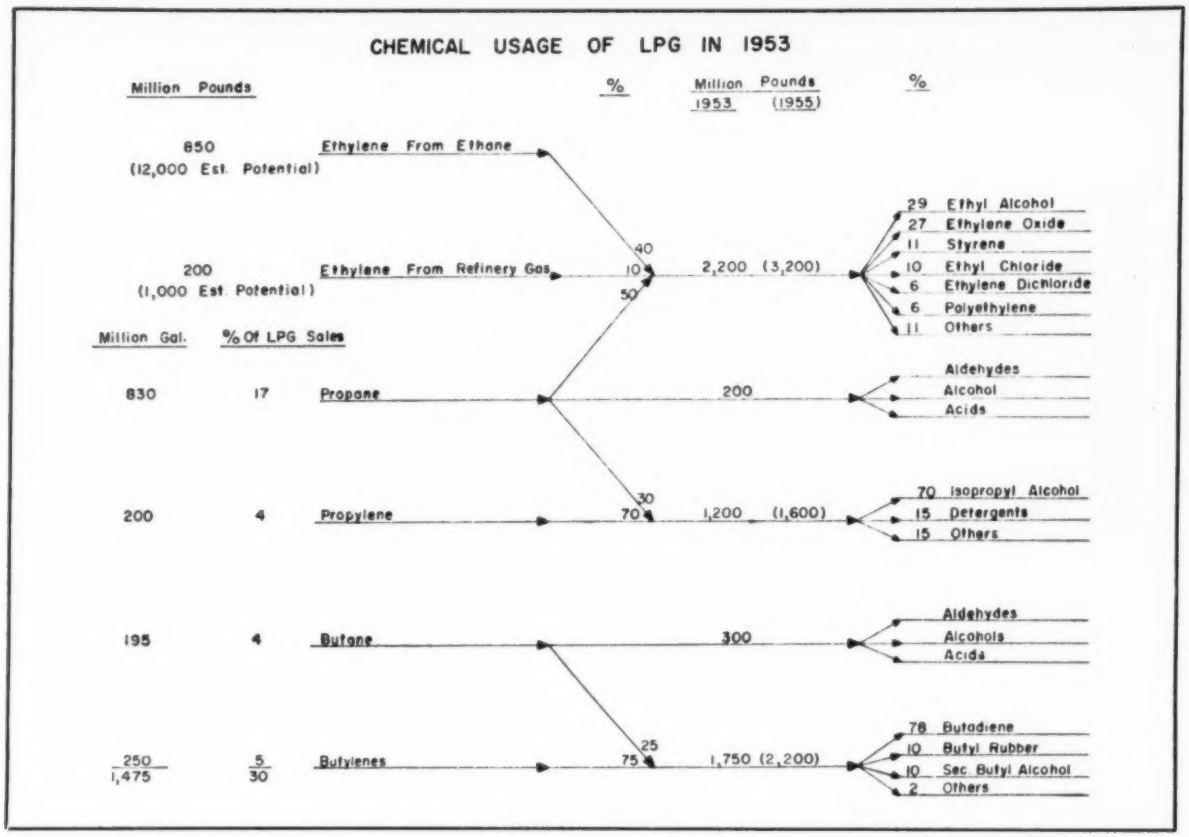
MCC also started construction early in February on a 120-ton addition to the nitric acid facilities. Virtually 100 percent of the processing equipment required for this unit has been purchased from Europe. The stainless steel processing unit itself comes from Germany; and the compressor, a type not before used in this country in the manufacture of nitric acid, was purchased from Switzerland.

Construction was also started in January on MCC's new ammonium nitrate prilling unit which will bring their total prilling capacity to approximately 500 tons of ammonium nitrate per day.

Upper photo gives a general view from the highway of Mississippi Chemical's plant with the office in the foreground, nitric acid, ammonia storage facilities in the background toward the right, gas reforming plant in the center background, and the compressor section of ammonia synthesis in the left background.

Lower photo shows the new gas reforming facilities at the right, with the nitric acid units in the center background and the old gas reforming section to the left. To the extreme left is the compressor building which was extended to handle the additional compressor capacity.

Nitric acid unit: Equipment from Europe.



The Chemical Industry Looks at LPG

It sees that consumption of these basic hydrocarbon raw materials amounted to millions of pounds last year. A tremendous increase is expected in 1955.

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THE CHEMICAL industry differs from other industries principally in the fact that it has extreme flexibility in the raw materials it uses, in its processing techniques, and in the tremendous variety of products produced. This flexibility makes for intensive competition at every level between different products for the same markets, between different processes to make the same products and between different raw materials to make the same products.

Many problems arise from these distinctive characteristics of the industry. The first of these is the very high capital investment required. This is well illustrated by the difference in investment requirements in the LPG and chemical industries. The investment required for the recovery of LPG may be roughly estimated to be in the range of $1000 to $1500 per barrel per day of LPG produced. The investment required to convert this same LPG to polyethylene is in the neighborhood of $70,000 per barrel per day of polyethylene produced.

Another major problem arising from the extreme flexibility of the industry is that of marketing. Markets must first be developed for the tremendous number of products that may be produced. Then, since chemicals are usually sold directly by the manufacturer and normally have highly specialized applications, extensive technical service must be provided.

A third major problem arising from the flexibility of the industry is the keen competition between raw materials. There are few of the 7000 chemicals now produced by the industry that are not or cannot be made from alternate raw materials. For this reason it is continually looking for cheap and more abundant raw materials.

Among the raw materials the chemical industry looks at is LPG. Since LPG is largely a byproduct of the production and processing of crude oil and natural gas, it has become relatively plentiful and inexpensive. For this reason it has become an important chemical raw material.

Petroleum based chemicals repre-

HERE IS the analysis of (1) the present sources and quantities of specific hydrocarbon raw materials used by the chemical industry and the chemicals produced: (2) the probable future production of these chemicals and increased requirements for LPG: and (3) the probable directions to which the chemical industry will look for these increased requirements.

sented approximately 25 percent of the total production of chemicals in this country in 1953. The major portion of these chemicals was produced from hydrocarbons classified as LPG. Because of the interrelationships it is necessary to include ethane and ethylene in this discussion along with propane, propylene, butane and butylenes.

The magnitude of the demand for LPG for chemical manufacture is illustrated by the fact that chemical production, including synthetic rubber, accounted for approximately 30 percent of LPG sales in 1953. There is most certainly interest in the probable future market the chemical industry offers for LPG. The reason for this interest is evident from a glance at Figure 1.

Present Requirements

Ethylene—The most important of the chemical raw materials being considered is ethylene. Approximately 2200 million pounds was consumed in 1953. Of this quantity approximately 10 percent was recovered directly from refinery gas, 40 percent was produced by pyrolysis of ethane recovered from natural and refinery gas and 1150 million pounds or roughly one-half produced by the pyrolysis of propane. The utilization of the propylene produced as a byproduct of ethylene production from propane will be discussed later.

The largest consumer of ethylene is ethyl alcohol. An estimated 29 percent of the ethylene produced in 1953 was consumed for this purpose. Fermentation alcohol is being replaced largely by this synthetic material. The principal use of ethyl alcohol is in the manufacture of acetaldehyde. Large quantities of acetic acid and other derivatives are also produced.

Ethylene oxide is the second largest ethylene derivative utilizing an estimated 27 percent of the 1953 production. It has an impressive and rapidly growing list of derivatives, including ethylene glycol which is most widely used as an antifreeze, ethanolamine, acrylonitrile, detergents, synthetic fibers and plastics.

Styrene consumed an estimated 11 percent of the 1953 production of ethylene. Styrene is used in synthetic rubber, polystyrene plastics, latex paints, polyester resins and many other applications.

Probably the most rapidly growing market for ethylene is in polyethylene plastics which are widely used for wire insulation, packaging films, pipe and bottles. Production is expected to grow from the present 130 million pounds per year level to 500 million pounds per year in 1956.

Large quantities are also used in halogenated products such as ethylene chloride, ethylene dichloride, vinyl chloride and ethylene dibromide, which have a wide variety of uses.

The demand for ethylene derivatives is expected to continue its rapid rate of growth. Total requirements for ethylene in 1955 are estimated at 3200 million pounds, an increase of 45 percent over 1953.

Propane/Propylene—The total chemical consumption of propane in 1953, including production of ethylene and propylene and direct oxidation products, is estimated at 830 million gallons or 17 percent of total LPG sales. Approximately 70 percent of this was used for the production of ethylene (with byproduct propylene production) and the remaining 30 percent directly oxidized to alcohols, aldehydes and acids, such as methanol, formaldehyde, acetaldehyde, acetone and acetic acid, which find wide usage.

Propylene is growing in importance as a chemical raw material. Of the estimated 1200 million pounds (200 million gallons) consumed in 1953 approximately 70 percent was obtained by recovery from refinery operations and the remainder was obtained as a byproduct from the production of ethylene from propane.

Approximately 70 percent of the chemical utilization of propylene in 1953 was in the manufacture of isopropyl alcohol, the major outlet for which is acetone. Over 80 percent of the acetone consumed in this country is so produced. Acetone is used as a solvent and as a chemical raw material in the manufacture of plastics, solvents and other products.

One of the major new uses for propylene is in the field of detergents which claimed an estimated 15 percent of the propylene production in 1953. The polymer of propylene, dodecene or tetramer, is used to alkylate benzene to form dodecylbenzene. Dodecylbenzene in its sulfonated form is one of the principal synthetic detergents.

Another important utilization of propylene is in chlorination to allyl chloride which is an important starting material in the synthesis of glycerin, the new series of epichlorohydrin resins, insecticides and many other materials. Propylene is also used for acrolein, propylene oxide and glycol, butyraldehyde via the Oxo process and many other derivatives.

The continually growing demand for propylene in chemicals is expected to reach the 1600 million pounds/year (370 million gallon) level in 1955, an increase of 33 percent over 1953.

Butane-Butylenes—Consumption of butane for chemical production in 1953 reached an estimated 195 million gallons or 4 percent of total LPG sales. Approximately 68 percent of this butane was used for production of butylenes for butadiene production. The remaining 32 percent was directly oxidized to aldehydes, alcohols and acids.

Butylenes produced from butane or recovered in refinery operations are used in the production of a relatively small but growing number of large volume products. An estimated 1750 million pounds (340 million gallons) was consumed last year of which approximately three-fourths was obtained by recovery from refinery gases and one-fourth produced from butane.

Approximately 78 percent of the butylenes consumed was used in the production of butadiene, the major component in GR-S, the principal synthetic rubber. There is also an increasing interest in butadiene as raw material for the synthesis of nylon intermediates, copolymers for latex paints and a host of other derivatives.

Approximately 10 percent of the butylene consumption was in the form of isobutylene, used in the manufacture of GR-I or butyl rubber which is important in the manufacture of innertubes. Another important outlet for normal butylene is in the manufacture of secondary butyl alcohol which in turn is converted to methyl ethyl ketone.

Small quantities of butylene are also used for the production of polybutylene for uses such as viscosity index improvers, lube oil additives, rubber modifiers and adhesives.

The demand for butylenes in the chemical industry is expected to grow to 2200 million pounds per year in 1955, a gain of 26 percent over 1953.

Future Requirements, Sources

As the chart indicates, the largest increased requirement for chemical raw materials from the LPG industry

by a wide margin will be in the field of ethylene derivatives where the annual consumption of ethylene is expected to increase by approximately 1000 million pounds or 45 percent from 1953 to 1955.

Two factors of economic importance regarding ethylene supplies are: (1) Ethylene is a vapor under normal handling conditions and is not economically transportable for any great distance. It must therefore be produced near the site of its consumption; and (2) the relationship of ethylene manufacturing costs to plant size. Ethylene manufacturing costs increase very rapidly as plant size is reduced. The newest ethylene plants have capacities in the neighborhood of 200 million pounds per year. This means that large quantities of raw materials must be available.

There are three principal potential sources of material to meet increased ethylene requirements: (1) recovery from refinery gases, (2) pyrolysis of ethane from natural and refinery gas, and (3) pyrolysis of propane. Relative availability and cost will largely determine which of these sources supply the additional ethylene.

Refinery gases represent a relatively cheap basic source of ethylene since the contained ethylene is available for a separation cost plus equivalent fuel value. Since the concentration of ethylene in these streams is relatively small recovery can be justified only in large scale operations. One advantage of this source of ethylene is that in many cases it offers a supply of raw material relatively close to the chemical end product market since there has been an increasing trend toward the location of refineries near points of ultimate product consumption. In 1953 the total recoverable ethylene potentially available in refinery gases is estimated at 1000 million pounds. Of this amount approximately 200 million pounds or 20 percent was utilized. There will undoubtedly be some increase in future recovery of ethylene from this source.

There are very large quantities of recoverable ethane potentially available primarily in natural gas. The ethylene equivalent of such ethane available in 1953 is estimated at 12,000 million pounds. Only an estimated 850 million pounds or 7 percent was utilized. The rapid growth of the gas transmission industry with the resulting trend toward processing of natural gas on a very large scale has made this an increasingly attractive source of ethylene. Three large ethylene operations of this nature are under construction or have recently been placed in operation. Since the relative value of ethane depends almost entirely on its alternate use as a gaseous fuel, the long term price should be relatively stable, increasing gradually as fuel gas prices rise. Production of ethylene from this source will probably continue to grow rapidly.

The future production of ethylene from propane will depend almost entirely on its price. At its present price of approximately 3.5 cents per gallon f.o.b. producing plants in the Southwest, it is definitely competitive with other sources of ethylene in large scale ethylene manufacturing operations in that area. Any appreciable increase in propane price will shift the economic advantage to other sources of supply. If all of the estimated one billion pounds per year increase in ethylene requirements by 1955 were supplied by pyrolysis of propane an additional 680 million gallons per year of propane, or 82 percent over 1953 consumption, would be required. Since increased quantities of ethylene will be supplied by refinery gas and ethane sources, increased consumption of propane for ethylene manufacture will be at some level below this. This level will be determined largely by the future price of propane.

A new operation which has an important role in establishing the value of ethylene raw materials is that of a Gulf Coast refiner manufacturing ethylene on a large scale by recovery from refinery gases and pyrolysis of ethane and propane. The ethylene from this operation is delivered by pipeline to customers in the area. Because of the large scale raw materials gathering, manufacturing and distributing operations this ethylene can be produced at a relatively low cost on a long term basis.

No mention has been made of other potential sources of ethylene which will probably become increasingly important in the future. The more obvious of these potential sources are pyrolysis of heavier hydrocarbons such as natural gasoline and crude oil, recovery from coke oven gas, and pyrolysis of oil shale. It is significant that a major chemical company recently bought large oil shale reserves.

Propane consumption for direct chemical utilization such as oxidation will probably increase. The probable increase is small, however, compared with the quantities used for ethylene manufacture.

Propylene requirements are expected to increase approximately 400 million pounds (92 million gallons), or 33 percent, from 1953 to 1955. Since most of the propylene is supplied directly from refinery operations this increased demand will have no direct effect on the propane market.

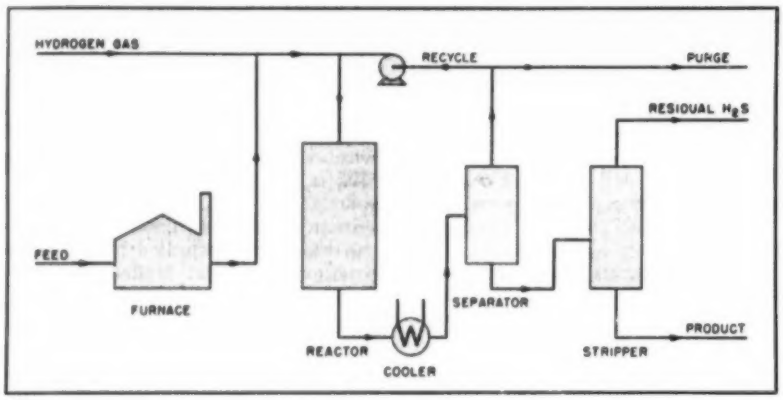
The probable increase in butane consumption for oxidation processes and other direct means of chemical utilization is small compared with that used in butylene and butadiene manufacture.

The estimated increase in annual consumption of butylene from 1953 to 1955 is approximately 450 million pounds (88 million gallons), or 25 percent. If all of this increased requirement were supplied by dehydrogenation of normal butane, an additional 130 million gallons per year of normal butane would be required, an increase of 67 percent over 1953 consumption. It is difficult to estimate what portion of this requirement will actually be supplied by butane and what portion will be obtained directly from refinery butylene supplies. The portion of the increased demand supplied by each source will depend primarily on the future disposition of the government's synthetic rubber facilities and the relative costs of the two materials. Normal butane at present prices of 4 cents per gallon f.o.b. producing plants compares very favorably as a raw material for butadiene manufacture with butylenes at today's prices in the range of 15-18 cents per gallon. The competitive and primary outlet for butylenes is the production of alkylate, a high octane gasoline blending component. The price of butylenes is largely dependent on their value in this use.

In summarizing the estimated increase in chemical requirements for propane and normal butane, the materials of most interest to the LPG industry, it appears that the maximum increased quantity of propane required by 1955 would be approximately 680 million gallons or 82 percent over 1953 consumption if no additional ethylene were obtained from other sources. In all probability, however, some of the increased ethylene requirement will be obtained by recovery from refinery gas and a much larger portion, dependent largely on the price of propane, from the pyrolysis of ethane. The increasing use of ethane offers LPG producers opportunity for increased revenue through recovery of this material.

The maximum increased quantity of normal butane required for chemical production by 1955 would be 130 million gallons per year or 67 percent more than 1953 consumption if there were no increase in the use of refinery butylenes. The actual increased quantity required will be somewhat less, depending on price and availability of butylenes.

Original presentation was before the Liquefied Petroleum Gas Association National Meeting in Chicago, May 12.



For low-grade stocks, a hydrogen-finishing process. (Catalyst-metal oxides on alumina; pressure—55 to 500 psi; reactor temperature—550 to 800 F.; yield—100 percent.)

Hydrofining Now Numbers 19 Units

Process using hydrogen will upgrade a wide variety of stocks.

NINETEEN UNITS of a recently perfected refining process known as Hydrofining are to be built, and some have already been installed, in the United States, England, France, Germany and Canada. A wide variety of product , from gasolines to waxes, will be upgraded in these units.

All of the installations are for affiliates of Standard Oil Company (New Jersey) for which Standard Oil Development does research and engineering.

The process, which will be available to other companies under license, uses hydrogen to improve the quality and purity of gasoline, and other petroleum products. Another application is for removing undesirable sulfur materials from refinery intermediate oil products. In some plants these sulfur materials will be recovered and converted into sulfur.

Combined capacity of the 19 units will be 155,000 barrels daily. Three units in this country and two in England are already in operation, with a total capacity of 28,000 barrels per day.

Hydrofining fits into the present refinery trend toward higher octane gasolines. Modern refineries are "reforming" low octane petroleum fractions into high octane gasoline, and during the process they manufacture large quantities of hydrogen as a by-product. Hydrofining requires hydrogen. So, the hydrogen produced from reforming can be used to supply the Hydrofiner.

Petroleum products which can be upgraded by this process include waxes, turbine oils, transformer oils, premium lubricants and fuels for diesels, tractors, automobiles and home oil burners. Hydrofining is also effective in the pre-treatment, often necessary, of petroleum fractions which are to be processed in certain "fixed-bed" reforming units.

In the treatment of fuels, Hydrofining has shown it will successfully reduce high sulfur content, stabilize products for storage and shipping, reduce odor, prevent formation of gummy deposits and carbon residues, and generally correct those properties which might tend to foul engines and oil burners. Special conditions which provide very low cost operation have been developed for this type of treating.

Hydrofining can replace existing processes which involve treatment of products with strong acid, often followed by necessary re-distillation. Considerable savings result.

Hydrofining is a flexible process in which design and operation will vary with the oil feed stock and desired degree of treatment. In general, the oil feed enters a coil furnace, where it is heated to a temperature usually between 550 and 800 F. It then passes to a fixed bed reactor vessel together with the fresh hydrogen gas. In the reactor, the feed is treated in the presence of the hydrogen and a regenerable metal oxide catalyst at pressures usually between 50 to 500 psi. After leaving the reactor, the product is cooled before entering a separator from which hydrogen-rich gas is recirculated back to the reactor in amounts varying according to the specific requirements of the finishing operation. After separation, the product stream enters a stripper where any residual hydrogen sulfide gas is removed. Product yield is 100 percent on the oil feed.

Hydrofining Plants

Affiliates of Standard Oil (New Jersey)

COMPANY	Refinery Location	Status	Type Feed	Design Feed Rate B/SD
Esso Standard Oil Co.	Bayonne, New Jersey	Operating	Wax	2,500
Esso Standard Oil Co.	Linden, New Jersey	Under construction	Heavy thermal naphtha	7,640
Esso Standard Oil Co.	Linden, New Jersey	Under construction	Cracked heating oil	19,520
Esso Standard Oil Co.	Baton Rouge, La.	Planned	Virgin gas oil	26,200
Esso Standard Oil Co.	Baton Rouge, La.	Planned	Coker gas oil and naphtha	12,740
Esso Standard Oil Co.	Baltimore, Maryland	Under construction	Lt. virgin, lt. coker and heavy cracked naphtha	12,000
Esso Standard Oil Co.	Baltimore, Maryland	Under construction	Heavy virgin naphtha	3,000
Esso Standard Oil Co.	Baltimore, Maryland	Under construction	Heavy cracked heating oil	5,000
Esso Standard Oil Co.	Everett, Mass.	Planned	Heavy cracked naphtha	2,400
Esso Standard Oil Co.	Everett, Mass.	Planned	Heavy cracked heating oil coker heating oil	2,250
Humble Oil & Ref. Co.	Baytown, Texas	Operating	Heating oil	20,000
Humble Oil & Ref. Co.	Baytown, Texas	Planned	Lubes	4,850
Humble Oil & Ref. Co.	Baytown, Texas	Planned	Heavy cracked naphtha	12,000
Imperial Oil Ltd.	Sarnia, Canada	Operating	Lubes and waxes	600
Imperial Oil Ltd.	Edmonton, Canada	Under construction	Lubes	2,000
Esso Petroleum Ltd.	Fawley, England	Operating	Tractor fuel	3,705
Esso Petroleum Ltd.	Fawley, England	Operating	Solvent naphtha	1,583
Esso A.G.	Hamburg, Germany	Planned	Diesel gas oil	8,450
Esso Standard, S.A.F.	Port Jerome, France	Planned	Virgin gas oil	8,450

How to design . . .

Foundations for Self-Supporting Towers

Recent building code changes permit vast economies for the alert designer. Here are practical, workable solutions to foundation design problems.

Emmett G. Jackson,
The Lummus Company,
Houston

DO YOU STILL drive a horse and buggy in this new-car age? Of course not—yet many designers use the same procedure for designing footings that they did twenty years ago. By designing according to the current ACI building code, a savings of up to 50 percent of steel can be effected. This is the new method—pass a vertical plane at the face of the pedestal, extending completely across the footing, and compute the moment of forces outside the plane, about said plane.

Stability—The most important items to consider in the design of self-supporting towers are stability and soil pressure. Since no direct solution has been developed for determining the size of the foundation, a trial and error method is used. That is, the wind moment is computed at the base, the weights of the assumed foundation and backfill are added to the weight of empty vessel, and the maximum and minimum unit soil pressures are calculated. This is illustrated by the following examples.

CASE 1—

$$\frac{P_e}{A_b} + \frac{M_b}{S_b}$$

P_e = Total empty weight (kips)
A_b = Area of footing (sq. ft.)
M_b = Moment abt. base (ft. kips)
S_b = Section modulus of base (ft. cubed)

Note that the difference should never be less than zero; the ideal case is when the soil loading diagram (with the overturning moment included) forms a triangle, and the resultant of loads fall at the middle third point.

The maximum soil pressure is the larger of the following:

CASE 2—

$$\frac{P_o}{A_b} + \frac{M_b}{S_b}$$

P_o = operating weight (kips)

or

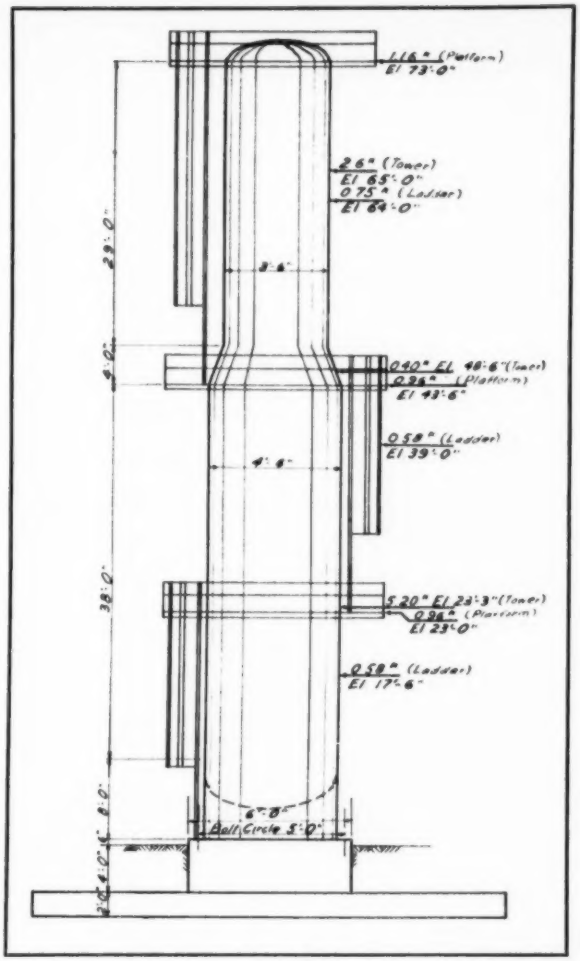


Figure 1

CASE 3 —

$$\frac{P_t}{A_b}$$

P_t = test weight (kips)

After investigating the three cases mentioned, the size and type of footing can be determined. Then a soil pressure diagram can be constructed, and the moment, shear and bond can be calculated according to sections 1204 and 1205 of the current ACI building code.

Anchor Bolts—Although anchor bolts sometimes are selected by the vessel designer the structural designer should always check them. One method of determining the size of anchor bolts is as follows:

$$\text{Net tension per bolt} = \frac{P_{ev}}{N} - \frac{M_{bc}}{S_{bc}}$$

P_{ev} = empty vessel wt. (kips)
N = number of anchor bolts
M_{bc} = moment of vessel at base ring (ft. kips)
S_{bc} = section modulus of bolt circle (ft. cubed)
D = diameter of bolt circle

$$S_{bc} = \frac{ND}{4}$$

$$\text{Net area} \quad \frac{\text{net tension per bolt}}{\text{allowable stress per bolt}}$$

It should be kept in mind that the net area is that at the root of the bolt threads.

Pedestal—The selection of pedestal steel may be made

Tower Foundation Design . . .

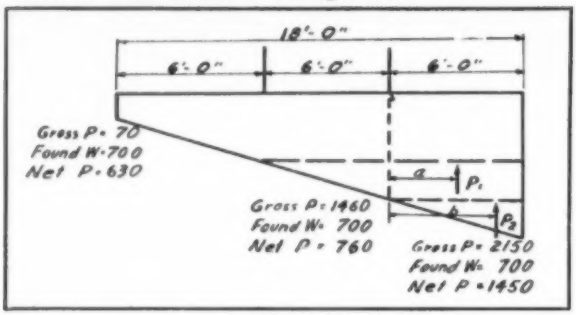


Figure 2

by using the largest result given by the application of the following two calculations:

(1) The moment of the tower can be computed at the top of footing, and, using the section modulus of the pedestal, find the required steel.

(2) The net area of the anchor bolts can be obtained, and an equal area of steel distributed uniformly around the face of the pedestal.

In no case should the total area of pedestal steel be less than the total net area of the anchor bolts.

In large pedestals, the problem of whether or not to make it hollow is not an easy one to solve. A recent check of field costs, however, indicate that pedestals of ten feet in diameter and less are more economical if made solid.

Sample Problem—Because of the numerous assumptions in determining the weights and wind shears, there is no justification for exacting calculations; therefore, slide rule computations are used throughout. A problem typical of that found in refinery design has been worked as follows: (see Figure 1).

Weights—
Vessel + Platforms

Empty wt. vessel	= 88.4 k
Operating wt. vessel + L.L.	= 102.0 k
Test wt. vessel + L.L.	= 147.8 k

TABLE 1
Moments

ITEM	Elevation	Shear	M Arm	M at Base
Ladder and Cage	17'6"	0.58K	23.5'	13.6 ft.K
Platform	23'0"	0.96K	29.0'	27.8 ft.K
Ladder and Cage	39'0"	0.58K	45.0'	26.1 ft.K
Platform	43'6"	0.96K	49.5'	47.5 ft.K
Ladder and Cage	64'0"	0.75K	70.0'	52.5 ft.K
Platform	73'0"	1.16K	79.0'	91.6 ft.K
Tower	23'3"	5.20K	29.25'	152.0 ft.K
Tower	48'6"	0.40K	54.5'	21.8 ft.K
Tower	65'0"	2.60K	71.0'	185.0 ft.K
Total	.....	13.19K	.....	617.9 ft.K

18'-0" Oct. Base

Wt. Ped.	= 20.1
Wt. Base	= 80.5
Wt. Backfill	= 95.3
Gross wt. empty	= 284.3
Gross wt. operating	= 297.9
Gross wt. test	= 343.7

Bolt Circle—Mean lever arm:

$$\frac{\text{M at Base}}{\text{Shear}} = \frac{617.9^k}{13.19^k} = 46.7' \text{ (above base)}$$

M. at Bolt Circle = 13.19 (46.7' — 6.5') = 530 ft. K

Check anchor bolts:

$$S = \frac{ND}{4} = \frac{12 \times 5}{4} = 15$$

$P_{ev} = 88.4^k$

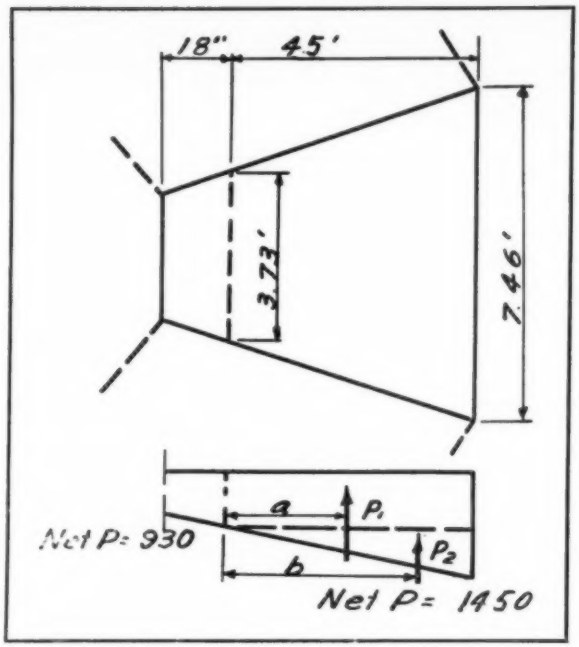


Figure 3

$N = 12$ bolts . . . $M = 530^k$

$$\frac{88{,}400}{12} - \frac{530{,}000}{15} = 7{,}400 - 35{,}400$$

Maximum tension per anchor bolt = —28,000 pounds.

$$\text{Required net area} = \frac{28{,}000}{20{,}000 \times 1.33} = 1.05 \text{ sq. in. per bolt}$$

(Note: Specifications usually permit an increase of 33 percent of unit stresses under wind loading.)

Net area of 1¼ inches round bolt = 1.29 sq. in. is greater than 1.05 sq. in.

Use twelve 1¼-inch round anchor bolts

Pedestal Steel—

Moment at bottom of pedestal = 13.19 × 44.7 = 590 ft. k
Erection wt. + pedestal wt. = 108.5^k
Area of pedestal = 29.8 sq. ft.
Section modulus of pedestal = 22.0

First Method

$$\frac{108{,}500}{29.8} - \frac{590{,}000}{22} = 3600 - 26{,}800 = -23{,}200 \text{ lb./sq. ft.}$$

$$\frac{23{,}200}{20{,}000} = 1.16 \text{ sq. in. steel required each face}$$

Second method

Net area in anchor bolts = 12 × 1.29 = 15.5 sq. in.

$$\frac{15.5 \text{ sq. in.}}{1.33 \times 16 \text{ bars}} = 0.73 \text{ sq. in. per bar}$$

Use sixteen No. 9 bars in pedestal. (No. 9 bar is 1⅛-inch in diameter.)

CASE 1—
Empty wt. + wind:

$$\frac{P_e}{A_b} \pm \frac{M_b}{S_b}$$

$$\frac{284{,}300}{268.4} \pm \frac{617{,}900}{592.5}$$

= 1060 ± 1040 = +2100 lbs. per sq. ft. or +20 lbs. per sq. ft.

CASE 2—
Operating wt. + wind:

$$\frac{P_o}{A_b} \pm \frac{M_b}{S_b}$$

$$\frac{297{,}900}{268.4} \pm \frac{617{,}900}{592.5}$$

$= +1110 \pm 1040 = +2150$ lbs. per sq. ft. or $+70$ lbs. per sq. ft.

CASE 3—

Test wt.:

$$\frac{P_t}{A_b}$$

$$\frac{343{,}700}{268.4} = +1280 \text{ lbs. per sq. feet.}$$

Moment in bottom of base, strip 1 foot wide (see Figure 2):

$$M = P_1 \times A + P_2 \times b$$

$$M = (760 \times 6) \times 3 + \left(\frac{690}{2} \times 6\right) \times \left(\frac{2}{3} \times 6\right)$$

$$M = 13{,}700 + 8300 = 22{,}000 \text{ ft. lb.}$$

Moment in top of base, strip 1 foot wide

$$M = \frac{700 \times 6^2}{2} = 12{,}600 \text{ ft. lb.}$$

Area of steel in bottom of base (unit stress increased 33 percent for wind):

$$\text{Area steel} = \frac{M^{(\text{in., lb.})}}{f_s JD} =$$

$$A_S = \frac{22{,}000 \times 12}{1.33 \times 20{,}000 \times .875 \times 19} = 0.60 \text{ sq. in. per ft.}$$

Use No. 7 at 10 inches cc (⅞-inch bars)

Area of steel in top of base:

$$A_S = \frac{12{,}600 \times 12}{1.33 \times 20{,}000 \times .875 \times 20} = 0.33 \text{ sq. in. per ft.}$$

Use No. 5 at 10 inches cc (⅝-inch bars)

Shear and Bond—(Approximate method. See Figure 3.)

V = total shear
v = unit shear
u = unit bond

$$V = 4.5\left(\frac{3.73 + 7.46}{2}\right) \times \left(\frac{930 + 1450}{2}\right) = 30{,}000 \text{ lbs.}$$

$$v = \frac{30{,}000}{44.8 \times .875 \times 19} = 40 \text{ lbs. per sq. ft.} \qquad \text{allowable} = 75$$

$$u = \frac{30{,}000}{5 \times 2.75 \times .875 \times 19} = 131 \text{ lbs. per sq. ft. allowable} = 240$$

The ideal footing for self-supporting towers is, of course, a circular foundation. For reasons of economy, that is, forming and placing of steel, octagonal footings are commonly used.

APPENDIX

Octagon

(See Figure A)

Area(A) = 0.8283 D^2 (sq. ft.)
Volume(V) = 0.03704 A (Cubic yds. per ft.)
Weight(W) = 0.15 A (kips per ft.)
Section modulus(S) = 0.1016 D^3 (ft. cubed)
a = 0.4142 D
b = 0.2929 D

Section Modulus of Bolt Circle

(See Figure B)

Section modulus for thin ring (Handbook):
$S = \pi\, tr^2$ as "t" approaches 0

$$S = \pi\left(\frac{D}{2}\right)^2 = \frac{\pi D^2}{4}$$

N = Number of bolts in bolt circle.

Perimeter $= \pi D = N$ as N approaches infinity

$$\pi = \frac{N}{D}$$

$$S = \frac{ND^2}{4D} = \frac{ND}{4}$$

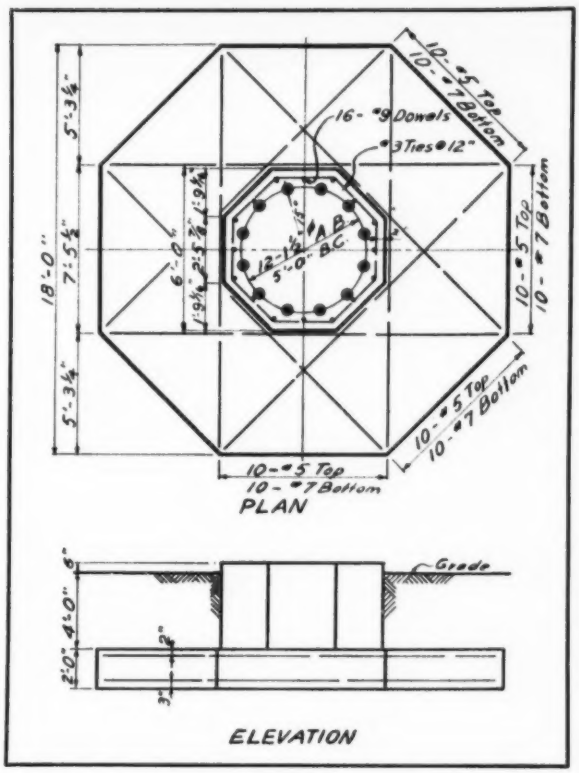


Figure 4

Exact Method of Determining Shear

(See Figure C)

$$\text{Shear} = (P_1 \times a \times b) + (P_1 \times a \times c) + P_2 \times a \times \frac{b}{2}$$

$$+ (P_2 \times a \times \frac{2}{3}C)$$

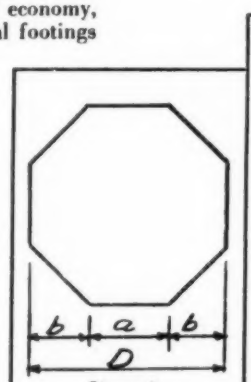


Figure A

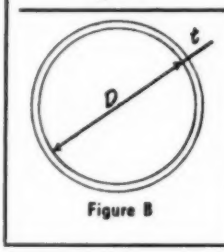


Figure B

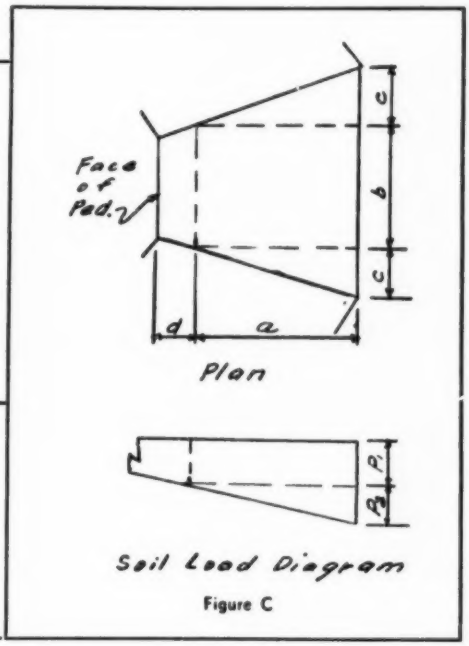
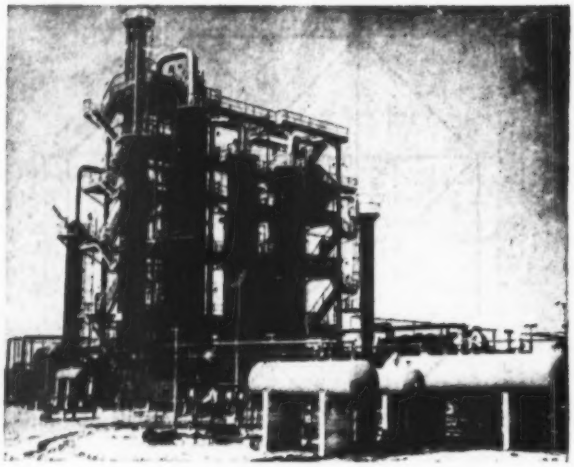
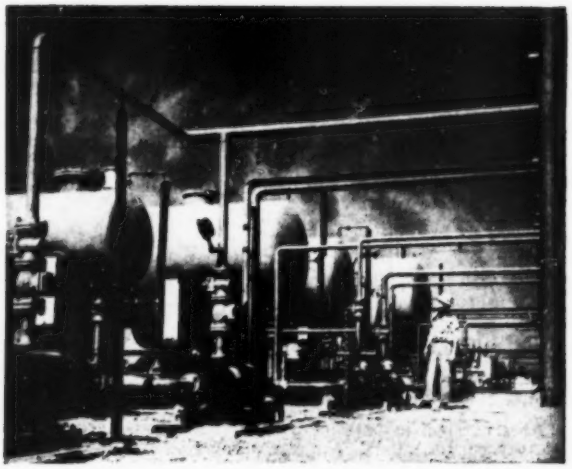


Figure C



Fractionating columns in purification of styrene.



Run-down tanks in styrene purification section.

Foster Grant Opens Styrene Plant

First company to integrate styrene production with final plastic product merchandising.

FOSTER GRANT Company, Inc., opened its new petrochemical plant in Baton Rouge, La., last month for the production of styrene monomer.

Styrene is the chemical source of polystyrene, principal molding powder used in the injection molding of plastics. Foster Grant Company, whose main plant is in Leominster, Mass., thus becomes the first plastics molder in the U. S. to establish its own primary supply of raw materials.

Construction of a styrene plant is the latest in a series of steps taken for the development and integration of Foster Grant. The company introduced the injection molding process of plastics manufacture into this country in 1931, and pioneered in the construction of dies and other equipment. Finding it difficult to obtain the proper molding powders, Foster Grant in 1950 set up its own polymerization plant in Leominster for making these powders. With the opening of its Baton Rouge facilities, Foster Grant completes within one corporate structure the entire cycle of production from purchase of refinery materials to merchandising of plastic products.

The construction of the Baton Rouge subsidiary represents an investment of nearly $4 million by Foster Grant. The plant, which employs certain chemical processes initiated in Germany, is the first of its kind in the United States.

In the compact unit, design emphasis is upon simplification, standardization of equipment, and a very high degree of instrumentation. With 250 instruments for automatic operation, the plant can be run continuously by a total of only 35 employes. When in full production, its capacity will be in the neighborhood of 2 million pounds of styrene per month.

The plant was laid out under the supervision of Dr. F. D. Mayfield, plant manager, who was formerly in charge of plant process design for the chemical division of the Celanese Corporation of America at Bishop, Texas.

The process of manufacturing styrene is as follows:

Ethylene gas and liquid benzene are brought into the plant from the nearby Esso Standard Oil Company refinery. These materials are reacted together in an "alkylation" reaction to produce ethylbenzene. The alkylated product is then separated into fractions by a distillation process. In this distillation process pure ethylbenzene is recovered; at the same time, the unreacted benzene and undesirable higher alkylate products are separated and recycled back to the alkylation reactor.

Ethylbenzene is then mixed with a large portion of steam, heated to a high temperature, and then passed over a very selective catalyst bed. In this catalyst bed, a dehydrogenization reaction takes place which converts a portion of the ethylbenzene to styrene while splitting out hydrogen. The reaction gases leaving this catalyst bed are cooled and condensed. The condensed steam is then separated from the ethylbenzene-styrene mixture.

In the final step, a difficult distillation process is employed to separate styrene from the unreacted ethylbenzene. At the same time, a small amount of by-product material is separated out. The recovered ethylbenzene is recycled back to the dehydrogenization reactor.

The restored and highly purified styrene is then stored in refrigerated tanks until it is loaded into insulated tanks cars and shipped.

The product is known chemically as styrene monomer. Upon arrival at Foster Grant's plant in Leominster, this monomer is reacted with itself in a further process to form long chain molecules known as styrene polymer. The process converts the liquid styrene into polystyrene. After a series of purification and refining steps, the plastic is now ready for heating and injection under high pressure into molds to form plastic articles.

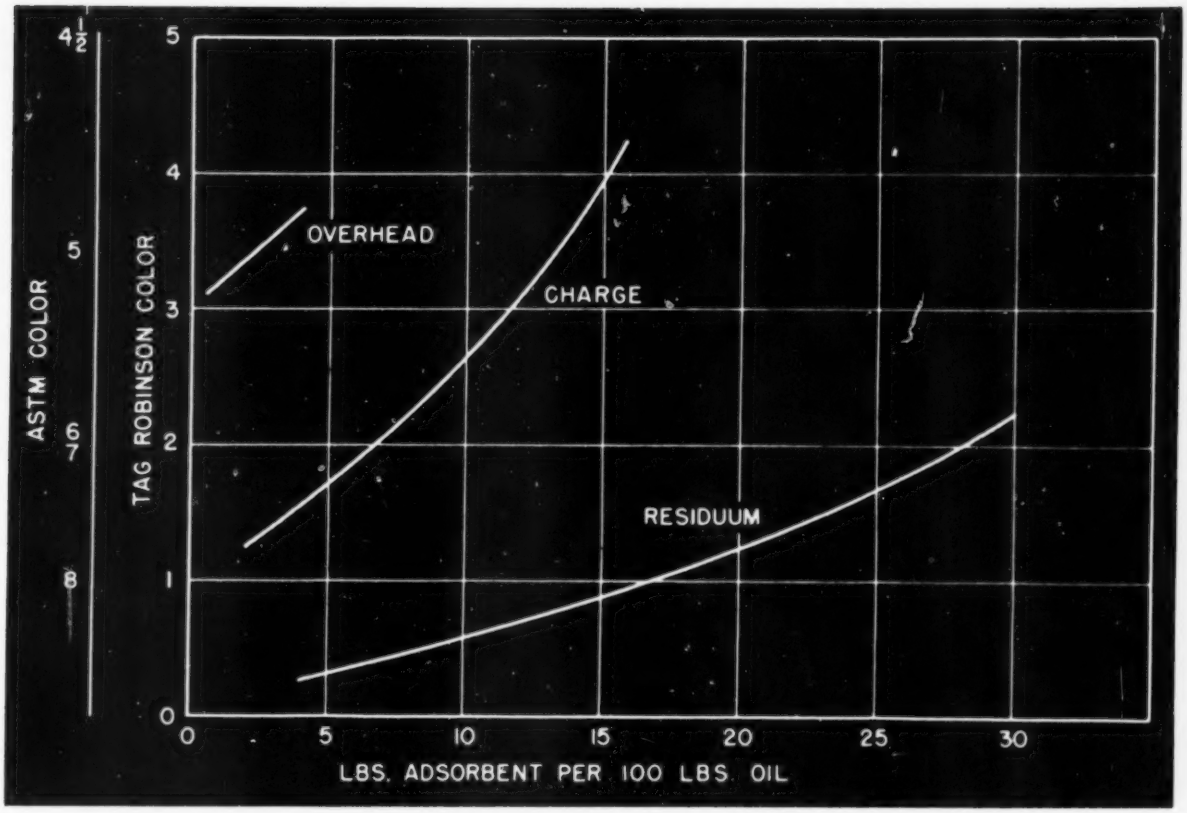


Figure 1. Contact decolorization of distillation overhead and residuum from unfiltered M.C. residuum. (Contact time—20 min., Temp.—700 F.)

In contact decolorizing . . .

Reduce Clay Dosages by 50 Percent

This study shows that major reductions in clay requirements can be made by distilling lube oil stocks into light and dark fractions before treatment.

E. B. Field*
Magnolia Petroleum Company,
Beaumont, Texas

THE ADSORBENTS employed in contact decolorization of lubrication oil are usually discarded after the initial use since the efficiency decreases rapidly when the clay is regenerated in conventional kilns. Clay cost is therefore one of the major expenses in the operation of contact plants and this discussion deals with a method of affecting major reductions in clay requirements by modifying a contact plant.

The Freundlich adsorption equation shows adsorbents to be more effective in removing color bodies from dark than from light colored products. The same equation further indicates that if two oils must be decolorized and blended, it is preferable to treat them separately and then blend rather than to blend first and then treat. Thus, the clay utilization might be improved by distilling the original oil and concentrating the color bodies in the residuum. Accordingly, a dewaxed raffinate from a Duo-Sol treated residuum of Mid-Continent origin was distilled in the laboratory to prepare a 78 percent volume overhead and 22 percent volume residuum. Physical properties of the oil, distillation overhead and residuum are presented in Table 1.

The original oil, overhead and residuum were decolorized to different color levels by contacting with various

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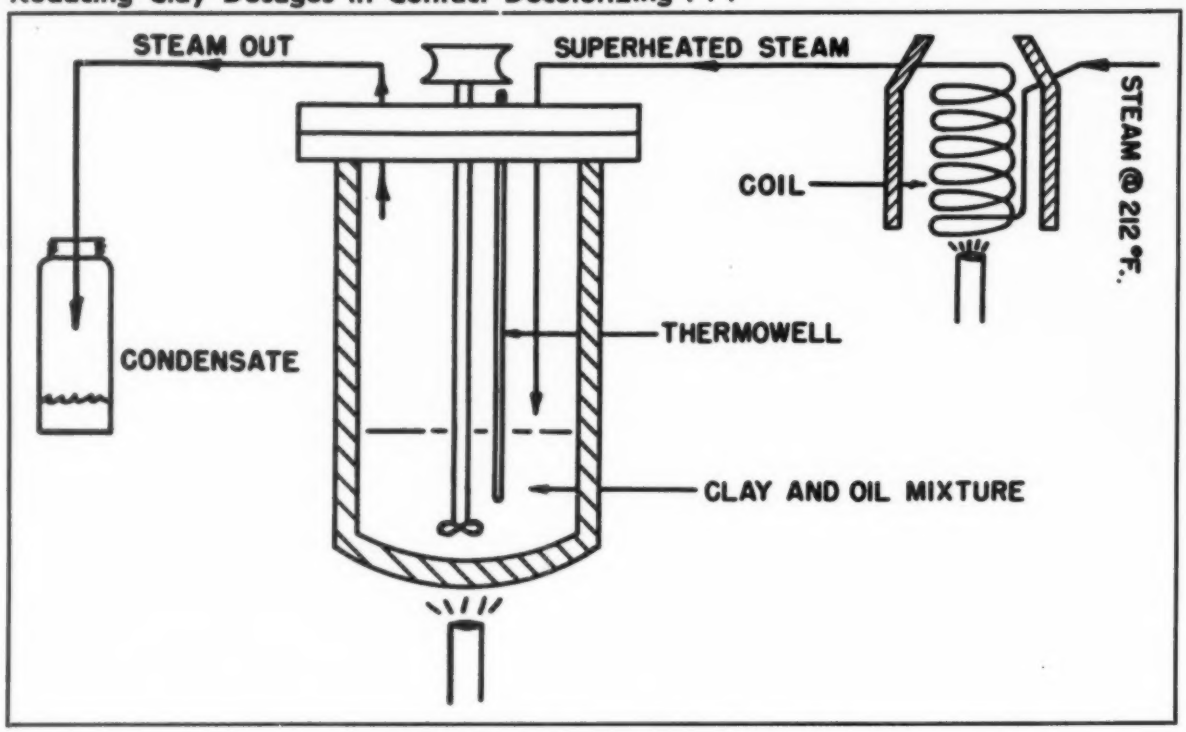

Figure 2. Laboratory contacting apparatus.

amounts of clay. A schematic diagram of the laboratory contact decolorization apparatus is shown in Figure 2.[1] In the procedure approximately 300 grams of oil were mixed with the desired amount of clay, heated to 700 F. and maintained at this temperature for 20 minutes. The vessel was blanketed with dry steam to prevent oxidation and subsequent discoloration of the product. After contacting, the slurry was cooled to about 400 F., filtered, and the color of the oil determined.

Process Described—Colors of the undistilled oil, overhead and residuum, after contacting by the above procedure, are shown in Figure 1. The distillation overhead, treated or not treated with clay, was blended with the clay contacted residuum in the ratio of the distillation yields, 78 percent overhead, 22 percent residuum. The total quantity of adsorbent required to secure a blend with a given color was compared with the amount of clay required to obtain the same color by contacting of the original undistilled oil. The desired 7 ASTM color on the undistilled oil was obtained by treating with 7.0 pounds clay per 100 pounds oil. An oil blend with a 7 ASTM color was secured by mixing the untreated overhead, 6— ASTM color, with the decolorized bottoms, 8 ASTM color. Approximately 3.5 pounds adsorbent per 100 pounds oil (based on original undistilled oil) are required to obtain the 7 ASTM color. Similar reductions in clay requirements are realized at other colors. The undistilled oil was decolorized to 6— ASTM color by treating with 9.4 pounds clay per 100 pounds oil and to an 8— ASTM using 5.0 pounds clay per 100 pounds oil. By distilling and treating the overhead and residuum separately, the adsorbent requirements can be reduced to 4.8 pounds per 100 pounds oil when a 6— ASTM color is desired and to 2.6 pounds per 100 pounds oil for the 8— ASTM color. Thus the adsorbent required for decolorizing a Mid-Continent residual oil can be reduced about 50 percent by distilling the oil in high vacuum and treating the overhead and residuum separately.

Importance of Color Stability—Color stability of the product is of much importance and the overhead and residuum must be treated with sufficient quantities of adsorbent to secure an oil having the desired stability characteristics. In this work the blend of the untreated overhead with the decolorized residuum had stability characteristics equal to that of the decolorized undistilled oil. The color change for the blended and original products after several days storage at 180 F. are shown in Table 2.

TABLE 1
Physical Properties of Distillation Charge Overhead and Residuum

Properties	Charge	Overhead	Residuum
Gravity, °API	25.3	25.7	23.4
Flash, COC, °F.	530	505	675
Pour, °F.	20	20	...
Color, ASTM	8+	6—	8+
SUS @ 100° F.	3,280	1,975	16,046
SUS @ 210° F.	180.0	127.7	541.5
Viscosity Index	97	93	...
C.C.R., % Wt.	0.98	0.59	2.24

TABLE 2
Color Stability of Blend of Untreated Overhead and Decolorized Residuum[1] from M/C Residual Stock

Time, Days	Storage Temperature, F.	COLOR, TAG ROBINSON	
		Decolorized Charge	Blend of Overhead and Residuum
0	180	2	2
1	180	1½	1½
2	180	1⅝	1⅝
3	180	¾	¾
4	180	¾	¾

[1] Residuum decolorized at 700 F., 20 minutes, 16 pounds Superfiltrol per 100 pounds oil

ACKNOWLEDGMENT

The writer would like to express his appreciation to the Magnolia Petroleum Company for permission to publish the manuscript.

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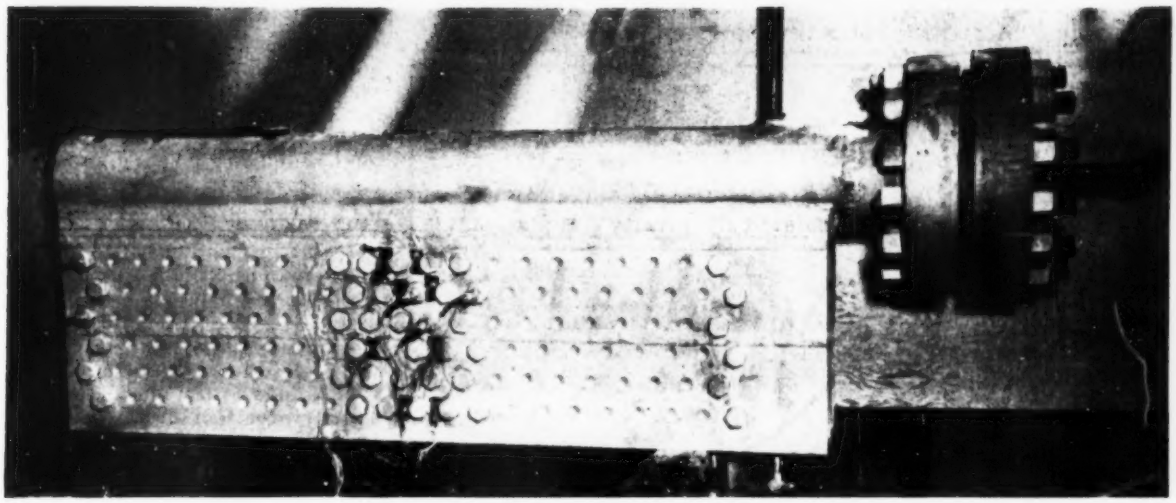

Figure 1. Box-type high-pressure header.

One solution for your water worries is the . . .

Air-Cooled Industrial Heat Exchanger

Its use eliminates such problems as water availability, chemical water treatment, corrosion, spray nuisance, freezing hazard and fouling.

S. Kopp and C. H. Homer, American Locomotive Company

IN THEIR EARLY application to industry air-cooled heat exchangers were designed on the basis of natural draft, or to take advantage of the prevailing winds. Their performance was often erratic, due to changes in the direction and velocity of the winds. More than 25 years ago one of the authors was associated with the design of a natural-draft air-cooled heat exchanger for condensing gasoline and reflux. This unit was essentially a vertical fire-tube boiler with a short stack. For over ten years the same refinery in which this unit was installed had used a horizontal shell-and-tube design consisting of a stack of four to six exchangers in series on the shell side. These were stacked so that alternate units were at right angles to each other to take advantage of the prevailing wind.

These first crude heat exchangers demonstrated the feasibility of such equipment, but indicated the necessity for mechanical draft to assure full performance at all times. The past 15 years have been the greatest period of development of air-cooled heat exchangers using mechanical air circulation. Because of this development installations costing $100,000 are quite common, and one plant, completed last year, contains air-cooled heat-exchange equipment costing over $1 million.

Air as a Cooling Medium—All heat is eventually dissipated to water or air. But although water covers a greater part of the earth's surface, it is not always available in the proper quantity or quality at the place where industry is located. Air is abundant, on the other hand, easy to handle, physically stable and noncorrosive except for areas of unusual air contamination. There is no upper limit to which air may be heated; the optimum heat-transfer rate and permissible temperature rise may thus be made the maximum for which it is feasible to design the heat-transfer surfaces of an air-cooled heat exchanger.

Another reason for the trend to air as a cooling medium is the sharp rise in industrial uses of water, causing water supply problems even in areas where water has always been abundant. The water requirements for typical industries are given in Table I, and point up the problem. As new processes are perfected, industries expand and power demands are increased, the question of the most economical use of water, or its elimination as a coolant, will become more important.

TABLE 1
Water Use in Typical Industries[1]

PRODUCTS	Lb. of Water Per Lb. of Product
Ammonium Sulphate	750
Butadiene	1200
Carbon Dioxide	175
Dry Ice	150
Hydrogen	2500
Lactone	750
Natural Gasoline	24
Oil Refinery (per Bl. crude)	60
Public Utility (per kw. generated)	600

Applications of Air-Cooled Heat Exchangers—There has been some use of air-cooled heat exchangers for condensing steam in power plants, the most notable being the portable power

Note—Mr. Kopp is chief consulting engineer, Alco Products, American Locomotive Company, Dunkirk, N. Y.; Mr. Homer is plant manager, Beaumont plant, American Locomotive Company, Beaumont, Texas.

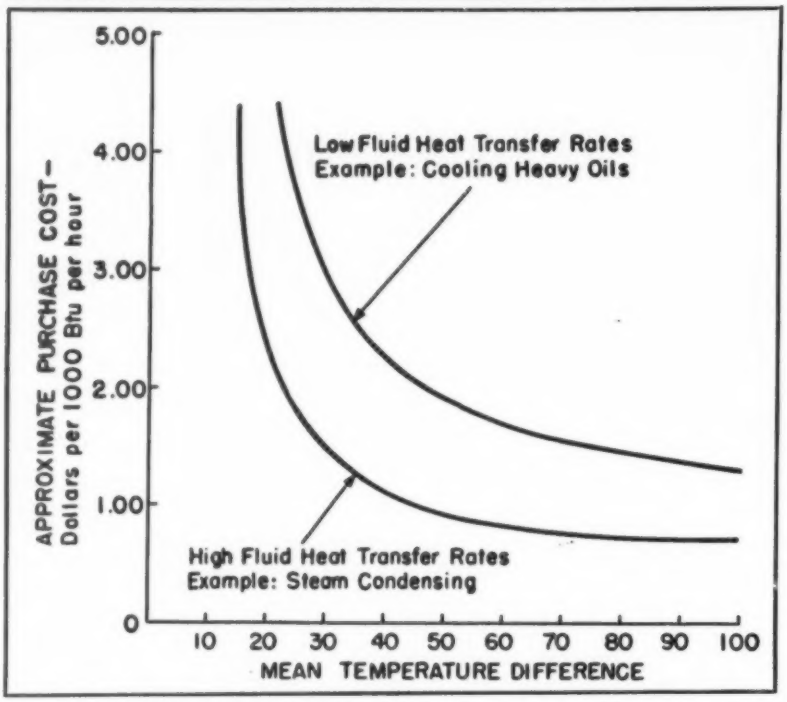

Figure 2. Approximate effect of hot-fluid heat-transfer rates on initial cost.

$$\text{MTD} = \frac{(T_1 - t_2) - (T_2 - t_1)}{\text{Log}_e \dfrac{(T_1 - t_2)}{(T_2 - t_1)}}$$

Where: T_1 — Fluid Inlet Temperature in °F.; T_2 — Fluid Outlet Temperature in °F.; t_1 — Air Inlet Temperature in °F.; t_2 — Air Outlet Temperature in °F.

plants built during the war.[2] The most frequent use has been for jacket-water, lube-oil and gas coolers for gas- and diesel-engine-driven compressor and pumping installations.

Typical of the application of this equipment is the following list:

Liquid Cooling
(a) Engine and compressor jacket water
(b) Lube oil
(c) Absorption and quenching oils
(d) Edible oil
(e) Amine solutions
(f) Glycol solutions

Vapor Cooling and Condensing
(a) Gasoline—straight run, cracked, and natural
(b) Steam
(c) Ammonia
(d) Still, reflux and overhead vapors
(e) Pentane
(f) Reactor overhead

Types of Air-Cooled Heat Exchangers—The usual air-cooled heat exchanger in process plants is either the induced- or forced-draft type with the heat-transfer surface arranged horizontally. A few units with vertical heat-transfer surfaces are used, principally for jacket-water and lube-oil cooling.

Both the forced-draft and induced-draft types of air-cooled heat exchangers offer advantages inherent in their design and operating characteristics. The forced-draft type is generally preferred for high-temperature cooling when the discharge air temperature is high enough to damage the fan. The induced-draft type permits discharge of the hot air at maximum velocity so that it is removed from the area, and cannot be picked up again by the fan and recirculated. The hood and fan duct also protect the heat transfer section from solar radiation, rain, hail and freezing weather. This type gives better air distribution over finned-tube sections, and since the sections are closer to the ground, no walkways are needed.

Finned tubing constitutes the heat-transfer surface on units used for process work, and in many cases this design is used for jacket-water cooling. This is particularly true when danger of freezing may be a consideration. Radiator construction is used for low-cost jacket-water coolers, and has also been used for lube-oil cooling and steam condensing.

Finned-tube sizes used are $\frac{5}{8}$ and 1-inch o.d. with 5 to 11 fins per inch. The fins are $\frac{3}{8}$ to $\frac{5}{8}$-inch high. Normally they are soldered, but they may be welded or brazed to the tube. Tubes with fins are tightly wrapped, but not bonded to the tube, are used for jacket-water cooling. One tube manufacturer can furnish a tube with the fin extruded from the tube stock. Finned tubes of differing tube and fin metals are also available.

Structures are generally made up of structural shapes and fabricated steel plate. Some induced-draft units have been mounted directly on a concrete structure, eliminating the steel supporting legs. Masonite panels, instead of steel plate, have been used on some forced-draft installations.

Fans up to six feet in diameter have either two or four blades, while the larger fans have four or more blades. It is common practice today to furnish adjustable-pitch fans, and variable-pitch fans are coming into use. The fans are adjusted to take care of seasonal changes in air temperature, thereby reducing the annual power cost. The average annual power cost will be 50 percent or less than that computed from the horsepower for design conditions. Variable-pitch fans are controlled by thermostat, generally installed in the drain line from the equipment. The thermostat automatically adjusts the fan-blade pitch to maintain constant outlet temperature.

Design Considerations—Air-cooled heat exchangers should be designed to cool the hot fluid to the highest final temperature that can be tolerated for short periods. The design air temperature selected should not be exceeded for more than two to three percent of the hours of the hottest months of the year. Design air temperatures (dry bulb) used are 90 to 105 F. for most installations, although one large pipeline installation was designed for operation with 122 F. air.

Most purchasers of air-cooled heat exchangers follow standard practice and supply the manufacturer with all necessary process information for selecting equipment. Air-side pressure drop or horsepower are generally not specified. It is common practice to limit air-side pressure drop to from 0.4 to 0.5 inches of water. For jacket-water coolers the fan horsepower is generally kept under two percent of the engine or compressor horsepower.

For purposes of making a preliminary study of fan horsepower requirements the following may be used:

Service	1000 Btu per hp
Jacket-water coolers	200-300
Exhaust-steam condensers	300-500
Hydrocarbon overhead condensers	200-400
Compressor gas coolers	300-500

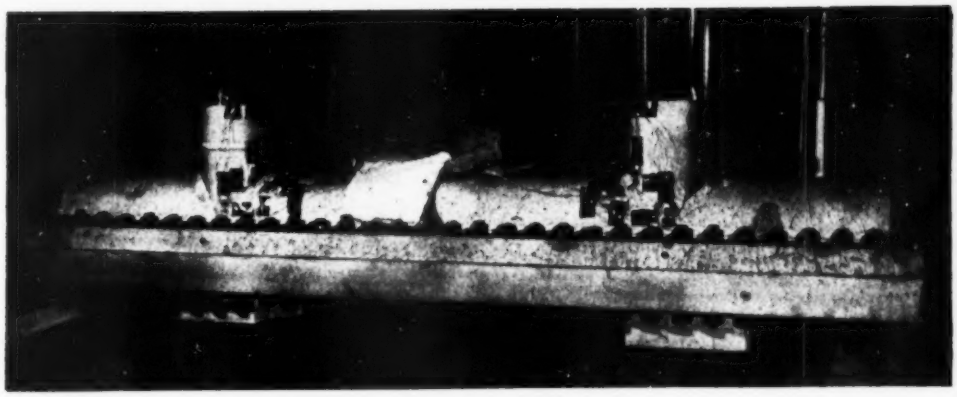

Figure 3. Low pressure header.

Whereas tube sizes and arrangements have been standardized for the bare-tube shell and tube exchangers that are used in the process industries, this is not the case with finned tubes. Each manufacturer uses finned tubes of his own choice, and as a result published data on finned-tube heat-transfer coefficients should be used with caution. Slight changes in tube arrangement may change heat-transfer and pressure-drop characteristics 20 to 30 percent. The responsible manufacturer checks each new fin design and tube-fin design or arrangement in a wind tunnel to establish the heat-transfer and pressure-drop characteristics to be used for the design of the exchanger.

Fin-Tube Sections
(a) Tube material, size and thickness
(b) Fin material, size and shape
(c) Fin bond efficiency
(d) Header type

Air-Moving Equipment
(a) Power source
(b) Power transmission to fan
(c) Number and size of fans
(d) Fan material and design

Structure
(a) Slab or pier foundation
(b) Induced or forced-draft design
(c) Structural stability
(d) Ladders, walkways and handrails
(e) Belts, reducing gears, shaft and fan guards

Controls
(a) Temperature control instruments
(b) Power control instruments
(c) Louvers, rolling doors
(d) Mixing valves

Economic Factors in Selection—As in almost all equipment, the economic factors in the selection of air-cooled heat exchangers are first cost, operating cost and maintenance cost. Figure 1 shows the effect of the temperature level on the purchase price of air-cooled exchangers. The first cost of the equipment is shown as a function of the mean temperature difference (mtd) between the hot fluid and the air. The mtd may be estimated from the desired inlet and outlet temperatures of the hot fluid, the maximum design ambient air temperature and the discharge air temperature. Appropriate correction factors[3] are applied to the mtd in actual design, but they may be neglected in using the chart.

Surface requirements vary with the heat-transfer characteristics of the fluid being cooled, and the approximate effect of hot-fluid heat-transfer rates on initial cost is also shown in Figure 2.

A comparison of Figure 2 with cost data on conventional shell-and-tube coolers and condensers using water as a coolant often indicates an important saving in first cost in favor of the air-cooled heat exchanger. This is so because the cost of water-cooling equipment must also include accessory water piping, pumps, and disposal or recirculating and cooling equipment. Air, on the other hand, does not have to be pumped to the location.

The air-cooled heat exchanger size is selected with primary consideration to the fan horsepower requirements. The rating engineer selects the optimum amount of surface based on power costs. Reduction in surface can be accomplished, within limits, by increasing the air velocity and thus increasing the air-side heat transfer rates, but this is done at the expense of higher fan horsepower. Usually the connected fan horsepower falls in the range of two to five horsepower per million Btu per hour, although variations beyond these limits do occur. The power requirements of a properly selected air-cooled heat exchanger are small in comparison with the usual cost of moving water or other liquid coolants because of the high efficiencies (70 percent or more) of the axial-flow fans, and the short distance through which the air flows.

Fan brake horsepower is calculated from the formula:

$$\text{fbhp} = \frac{(\text{sp} + \text{vp}) \times \text{acfm}}{6370 \times \text{e}}$$

where fbhp = fan brake horsepower; sp = static pressure drop through unit; vp = velocity pressure of air stream; acfm = actual cubic feet of air per minute through fan; and e = fan efficiency.

Fan brake horsepower on many air-cooled heat exchanger models may be varied to follow changes in ambient air temperature, or service requirements, with attendant saving in power costs. multiple-fan units may be operated with some fans shut down, or fans may be equipped with two-speed, variable-torque motors. Fan-blade pitch is adjustable on all models. The controllable-pitch fan, with accessory instrumentation, provides almost infinite control of power requirements with a fixed-speed driver.

The maintenance cost of air-cooled heat exchangers is very low. Corrosion and fouling from the coolant is almost nonexistent. Therefore the tubes and headers are usually selected of an alloy known to be adequately resistant to corrosion from the process fluid. Since early failures on the air-coolant side of the tubes does not occur, these factors need not be considered in selecting materials of construction. Gears, motors and bearings used in air-cooled heat exchangers are designed for a minimum of attention and maintenance.

Typical Installations

Pipeline—The use of air-cooled heat exchangers for both petroleum and gas pipe lines has been quite extensive. One American pipe line has 227. Several other lines have 30 or more in service.

A Middle-East pipe line has 105

finned-tube units. These units cool water for engine and generator jackets and lube-oil coolers, with ambient air at 122 F. Since this air temperature is the maximum for only a small percentage of the year, each unit was furnished with three fans. The number of fans in operation is established by the temperature control located in the water outlet. During the design of this installation the sequence of fan operation was calculated to establish the control points for the instrumentation. Table 2 indicates the maximum ambient air temperature at which excess fan capacity will cut-out and still maintain design heat dissipation. For example, on unit A when the ambient temperature is 116 F. or lower the middle fan will stop. When the ambient temperature is 93 F. or lower the end fans will stop and only the middle fan will run.

TABLE 2
Sequence of Fan Operation on Pipe Line

UNIT	NUMBER OF FANS PER UNIT IN OPERATION VS. AMBIENT AIR TEMPERATURE			BHP Fan
	3	2	1	
A	122 F.	116 F.	93 F.	3.8
B	122 F.	120 F.	111 F.	3.7
C	122 F.	117 F.	98 F.	5.1
D	122 F.	119 F.	110 F.	2.6

On some gas pipe lines air-cooled heat exchangers are used for compressor intercoolers and aftercoolers. The headers for the higher pressures are generally of the box type shown in Figure 1. Low-pressure headers may be similar to that shown in Figure 3.

The header shown in Figure 1 is used for an aftercooler operating at 2300 psi. The specifications for this exchanger were that it be built to the ASME Code, to meet the requirements of the local laws. This construction is not fully covered by the Code rules, hence a proof test had to be performed. This was done by installing strain gages both internally and externally. In addition the external surfaces were coated with a brittle lacquer. This header was tested at increasing increments of pressure to a maximum of 4420 psi, in the presence of a licensed inspector and the purchaser's engineers.

Gas Plant—Natural gasoline and repressuring plants offer outstanding possibilities for air-cooled heat-exchanger installations. In one plant, where 80 percent of the cooling is accomplished with air, the air-cooled heat exchangers handle the cooling duty for engine jacket water, first-stage gas compression and primary cooling for still and debutanize overheads. The products cooled by water are limited to final cooling on second-stage gas (summer only), absorber intercooler, lean-oil coolers, still overhead condenser (final cooling only) depropanizer overhead, debutanizer overhead and base, and butane product cooling. This is believed to be the first gas plant to use air-cooled heat exchangers to this extent. Its successful operation has led to numerous other installations in the past few years.

Oil Refinery—The use of air-cooled heat exchangers for general oil refinery cooling service is not too extensive at the present time. However, a number of installations have been made and given satisfactory service. The shortage of water during the past few years in the drought areas of the country has caused a number of refiners to give serious consideration to the use of air-cooled heat exchangers for cooling and condensing services.

The use of air-cooled heat exchangers for refinery processes will require some modification in the usual plot plan of the installation. Economics generally dictate that the air be discharged at a high temperature to conserve horsepower of the fans. This air must be discharged so as not to discomfort the operating personnel. To accomplish this, the equipment will have to be installed away from overhead walkways and stairs. In some cases this will lengthen the stream piping, a factor that should be considered in the economics study. However, in many cases the elimination of the water piping will more than offset the increased cost of the stream piping.

Table 3 gives data for four cooling and condensing services using Alco models in a crude distillation unit. All the air-cooled heat exchangers in this installation were furnished with steel tubes. Copper fins were soldered-bonded to the tubes. Because of the temperature range through the exchanger, the tube bundles were furnished with split headers to reduce temperature stresses on the tube joints. Each tube bundle has two 72-inch four-blade fans directly connected to electric motors. The 22 fans discharge a total of approximately 1 million scfm of air, varying between 120 and 172 F.

TABLE 3
Refinery Installation

SERVICE	Duty—Btu per Hr.	Finned Surface—Square Ft.	Number of Fans	Horsepower	Heat Transfer Coefficient—Outside Surface
Naphtha and Steam Condenser	17,200	37,053	6	57.6	4.1
Gas Oil Cooler	7,900	24,703	4	20.0	3.2
Topped Crude Cooler	14,700	37,053	6	46.8	2.2
Gasoline Condenser	17,200	37,053	6	57.6	3.8
Total	57,000	135,861	22	182.0	

Chemical Plant—Probably the most striking recent illustration of the trend toward air-cooling is the selection by a large chemical company of a total of 26 air-cooled heat exchangers for their Texas plant. In this plant, which produces acetic acid, acetic anhydride and their derivatives from light petroleum gases, 80 percent of the heat dissipation is handled by air-cooled heat exchangers.

Recent plant tests, after several months of operation, have more than justified the designers' choice of air-cooled heat exchangers for this exacting service.

All the air-cooled heat exchangers in this installation are used for condenser service. Among the services handled are organics, pentane, solvent recovery, still overhead and reactor overhead.

The air-cooled heat exchangers are furnished with stainless steel headers and stainless steel tubes with aluminum fins. This is the first installation using this combination of materials. Because of this fact and the size of the installation a number of experimental and special tests were performed before completing the design, and releasing it for fabrication.

In order to conserve the use of stainless steel, particularly for the high-pressure headers, a unique and new design was developed for the header. Before proceeding with the fabrication of these headers a carbon steel prototype was built, strain gages were installed at the critical areas, and the stresses calculated from the strains developed under bolting-up and hydrostatic test. One point of maximum stress was found, the design modified and retested. A satisfactory retest released the design for fabrication. Figure 3 shows the header under test.

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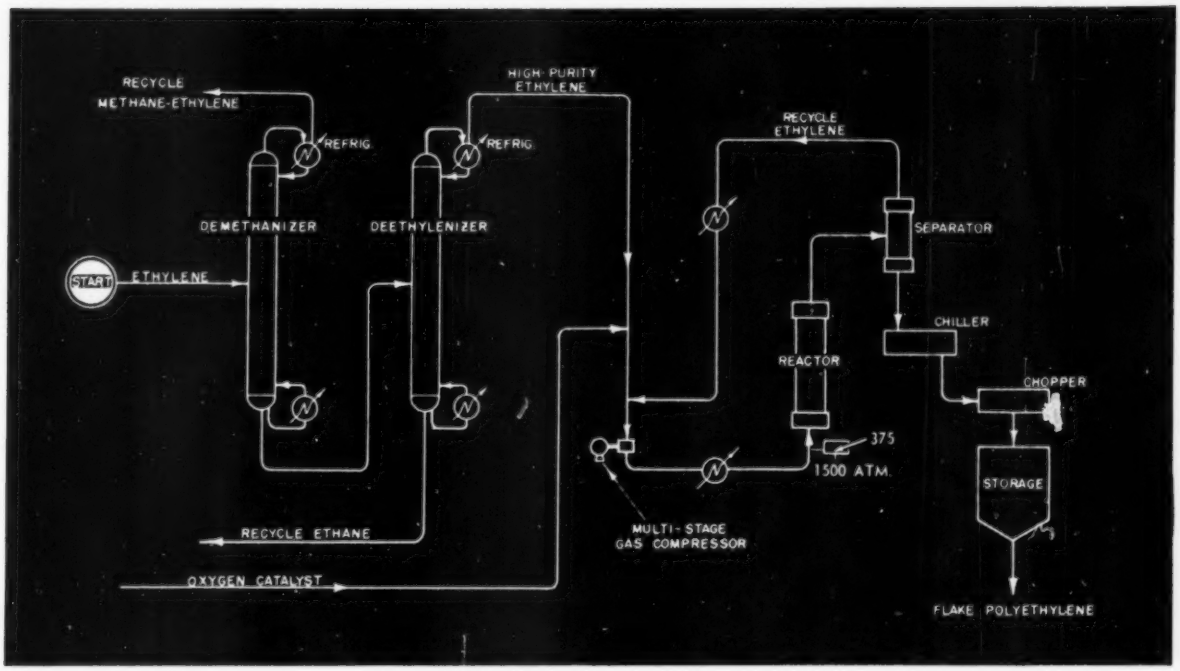

Figure 1. Process flowsheet for production of polyethylene.

Understanding the chemistry of . . .

Petrochemical Reactions

Part 12. The Oxidation of Olefins

◗ **Part 13. The Polymerization of Olefins**

Part 14. Alkylation Reactions

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University of Texas,
Austin

THE POLYMERIZATION of olefins and other vinyl-type compounds ($-\overset{|}{C}=CH_2$) to produce plastics is currently one of the most active fields in petrochemistry. The raw materials are olefins, diolefins, styrene, acrylic and methacrylic acid esters, vinyl chloride and acetate, acrylonitrile and related compounds. The leader is polyethylene, with nine companies putting one-fourth of a billion dollars into polyethylene plants which have an expected production capacity of 250 million pounds.

The large number of compounds which serve as raw material, along with the rapid growth in scientific knowledge and commercial application, make the discussion of vinyl polymers an involved process. Because of these factors, the present article will be confined primarily to the principles involved in the polymerization of vinyl compounds. Unsubstituted olefins will be used as illustrations because of their close relationship to the petroleum industry.

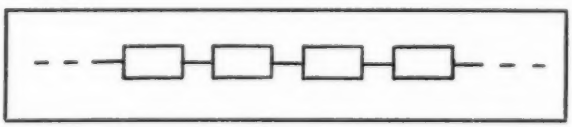

Figure A

Natural and synthetic high polymers are large molecules (macromolecules) consisting of repeating low-molecular-weight units. Each single unit is called a *monomer*, (i.e. ethylene), while the macromolecules are called *polymers*, (i.e. polyethylene). One particular structural characteristic is common to all molecules able to participate in the formation of a polymer: the molecule must be bi- or polyfunctional. Bifunctional molecules lead to linear-chain molecules. See Figure A.

Trifunctional molecules emulate the general who jumped on his horse and rode off in all directions. They produce complicated network-like structures as in Figure B.

Polymerization of Vinyl-Type Compounds

Olefins are of the bifunctional type with a biradical produced primarily by the collision of two energy-rich double

Polymerization of Olefins . . .

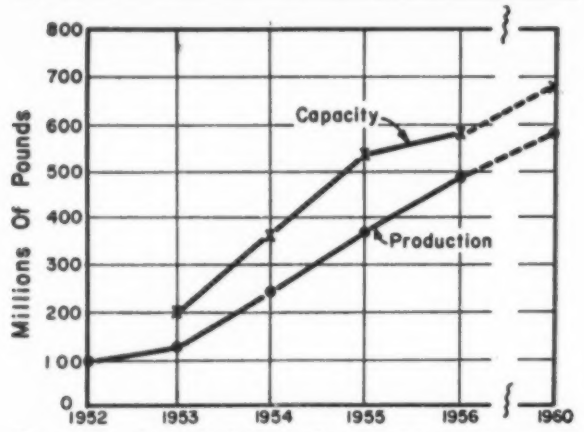

Figure 2. Growth of polyethylene production and increase in capacity.

bonded molecules.

$$\begin{array}{l} H\ H \quad H\ H \quad\quad H\ H\ H\ H \\ C::C + C::C \rightarrow \cdot C:C:C:C\cdot \\ H\ H \quad H\ H \quad\quad H\ H\ H\ H \end{array}$$

Once such a biradical is formed, other monomers collide with its active ends and in this way the growth of the polymer is in both directions from the original biradical.

This is a chain type of polymerization and consists of a number of steps which follow each other consecutively and rapidly. The intermediate products are unstable and are the stepping-stones to the next phase; thus, in one sweep, the final long-chain molecule is produced once the initiating step has taken place. A polymerization reaction of this type is subdivided into the following three principal steps:

- initiation (activation)
- growth (propagation)
- termination (cessation)

Each of these steps of the total polymerization chain reaction has its own mechanism and kinetics.

Initiation reaction—The energy to activate the carbon-carbon double bond is influenced by the substituent on the two carbon atoms and the presence of conjugated or multiple bonds. Substitution decreases the energy necessary for activation of the bond—especially if it is unsymmetric.

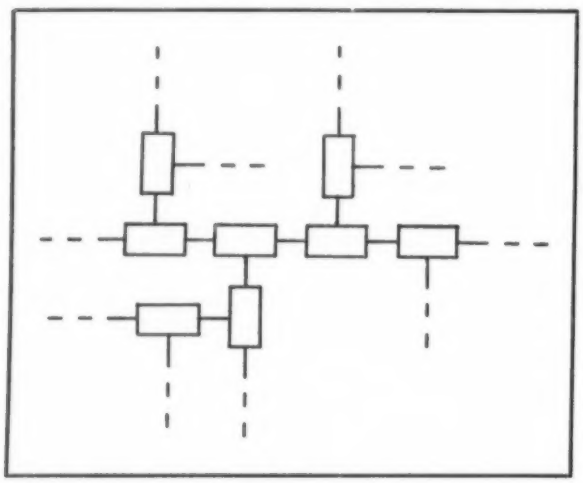

Figure B

The nature of the substituent also has a profound influence on the ease of polymerization: for example, propylene is easier to polymerize than ethylene, and vinyl chloride ($CH_2 = CHCl$) polymerizes more readily than propylene. Conjugation increases the ease of polymerization.

The double bond can be activated by heat or by irradiation, preferably with ultraviolet light; and, as in almost any other chemical process, a considerable increase in the rate of reaction can be obtained by the use of a catalyst. There are, therefore, three types of polymerization: thermal, photo and catalytic. Most of the theoretical and practical polymerization reactions are brought about by the use of catalysts, and most of the studies have been concentrated on this type of reaction. The polymerization of olefins and diolefins can be greatly accelerated by one of two types of catalysts, each of which is specific for certain polymerizations. The two are radical-type catalysts and ionic-type catalysts. Radical initiated reactions are accelerated by substances which under the reaction conditions, form radicals themselves. The most widely used catalysts of this type are organic and inorganic peroxides and salts of peracids. Benzoyl peroxide and *tert*-butylhydroperoxide give excellent results as hydrocarbon-soluble catalysts, and hydrogen peroxide, potassium perborate and potassium persulfate as water-soluble catalysts.

The mechanism of the catalytic action of highly polar molecules on a polymerization reaction has not been definitely established. It is known, however, that traces of water or low molecular weight alcohols must always be present as "co-catalysts" in order to induce some interaction between the polar catalyst and the monomer.

Propagation Reaction—Once an active center has been formed, it is able to react with another inactive monomer in an exothermal reaction step. The chain grows normally by continuous addition of new monomer units until a termination reaction stops further propagation. The activation energy of this process is between 6000 and 12,000 cal. per mole., and, consequently, a high percentage of the collisions between activated chain ends and inactive monomers are successful. Thus, the sequence of additions is very rapid. The reaction may also be propagated by a collision between two chains causing the formation of a branched chain. If there is a collision of a growing chain with either a monomer or an already completed chain, chain transfer may take place. All three of these types of chain propagation can and probably do occur simultaneously.

Termination Reaction—Radical chain polymerization reactions are commonly terminated by either a collision between two growing chains, collision of a growing chain with a catalyst radical, or collision of a growing chain with impurities or with the walls of the reaction vessel. The probability of collision between activated chain ends and catalyst fragments increases proportionally with the concentration of the catalyst in the system. This presents a problem—for high catalyst concentrations effectively accelerate the polymerizations by producing a comparatively large number of active centers. But on the other hand, a high catalyst concentration also provides chain breakers and prevents the development of long chains. In practice, therefore, some speed of polymerization has to be sacrificed if high-molecular-weight material is desired.

When polymerization is not desired, inhibitors are added to the monomers. They terminate reaction chains immediately after they are initiated by reacting with the chain carrying radicals. The most effective inhibitors are compounds containing quinoid, nitro, amino, or phenolic hydroxyl groups. Obviously they must be removed from

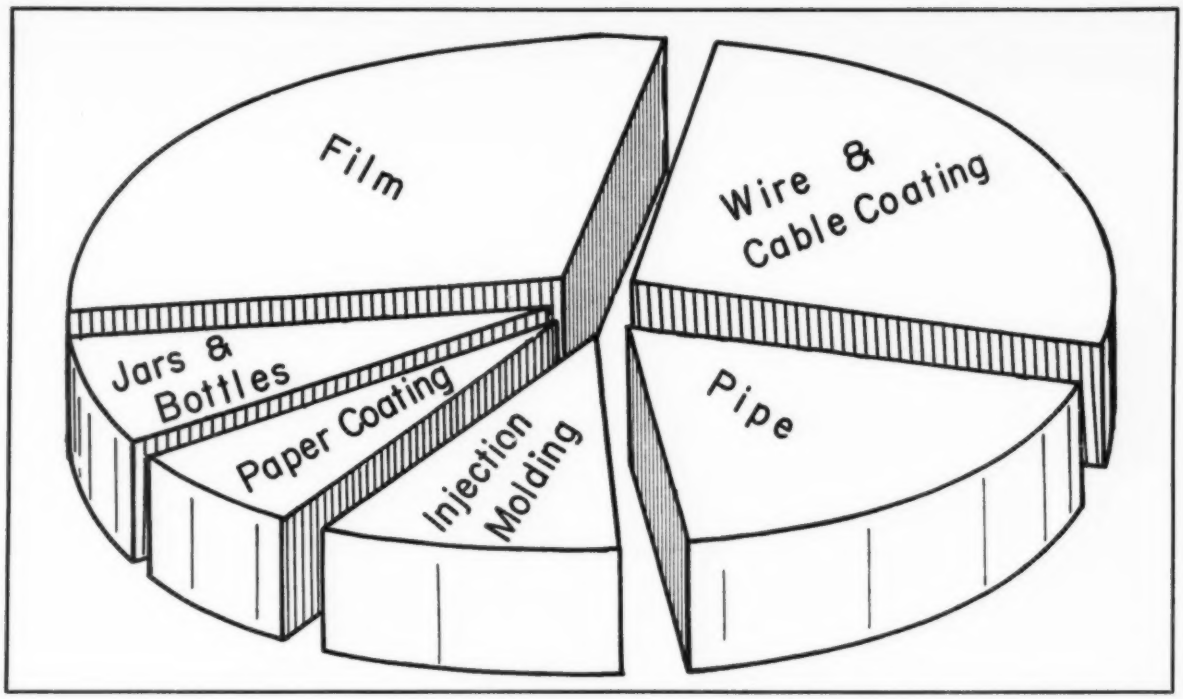

Figure 3. Estimated end-use pattern for polyethylene in 1953.

the monomer by washing or distillation before the monomer can be polymerized. Incomplete removal of the inhibitor results in a polymerization *induction period* during which the remaining inhibitor molecules are still busy inhibiting.

Production of Vinyl Polymers

Four methods of polymerization are used technically: (1) in bulk (mass or block polymerization), (2) in solution, (3) in emulsion, (4) pearl (suspension) polymerization. Which method is used is dependent upon economic considerations and on the use to which the polymer is to be put. The reactions of the same type are carried out basically in a similar manner for the production of various polymers and often the same machinery can be employed for different monomers. Temperature control is a very important factor in the choice of the polymerization process to be used. Catalyst control and purity of the product are also important.

Bulk Polymerization—Bulk polymerization consists of subjecting the pure liquid or gaseous monomer to polymerizing conditions. The main problem in this procedure is the efficient dissipation of the heat of the reaction. This is accomplished by a continuous and fairly complicated heat control system. This type of polymerization produces a product which is essentially free of impurities and thus is suitable for optical uses and for electrical insulating. It is also used for casting small quantities of small objects of intricate design, where molding operations would be too costly, and for large-scale production of molding powders.

Solution Polymerization—The problem of heat control is overcome if the monomers are dissolved in suitable solvents and the polymerization carried out in solution. This method is at a certain disadvantage, however, for it is a slow reaction giving a low-average-molecular-weight product which cannot be obtained free of traces of the solvent. The quantity of polymers produced by solution polymerization is small.

Emulsion Polymerization—Polymerization of one or more monomers in an emulsified phase overcomes the disadvantages encountered in bulk and solution polymerization. The liquid or liquefied monomers are brought into the emulsified state and the reaction proceeds very rapidly as compared with the two previously discussed methods. The average molecular weight of the resulting polymer is considerably higher than that of a product obtained under similar conditions by either bulk or solution polymerization. The emulsion polymerization method has become of outstanding technical importance because of these advantages, and a large proportion of the industrial polymers are made by this method—especially the synthetic rubbers. Emulsion polymerization, however, requires a number of additional ingredients for successful operation, and the presence of emulsifiers and other chemicals in the reaction mixture makes such polymers unsatisfactory for applications involving high optical clarity and excellent electrical insulating properties.

Pearl Polymerization—Pearl or suspension polymerization has the advantages of an emulsion polymerization with the product having the purity of a bulk polymer. In this type of polymerization, the monomer is polymerized while it is kept suspended, in the absence of emulsifiers, in a nonsolvent medium. By adequate agitation, the liquid monomer is dispersed into globules of varying size, and after the polymerization is finished the polymer has the form of regularly shaped spheres. The size of the pearls can be regulated by varying the rate and efficiency of stirring, the type and amount of suspension stabilizer, the temperature and catalyst concentration, the ratio of monomer to suspension medium, and the pH of the reaction mixture. Under proper reaction conditions, polymers of high purity can be obtained which can be separated easily

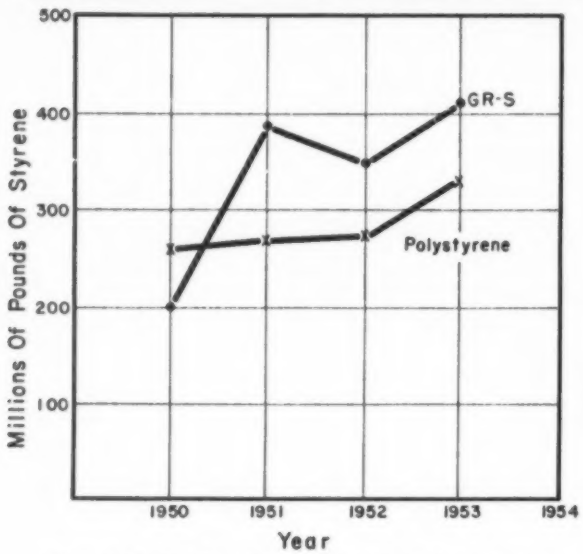

Figure 4. Consumption of styrene by its two major end-uses.

from the suspension medium. The pearls can be dried and conveniently stored, shipped, and used for subsequent molding and extruding operations.

What's Polymerized?

Probably more words have been written within the last several years about *ethylene* and its polymerization to *polyethylene* than about all of the other plastics combined. Polyethylene is the current darling of the petrochemicals, for it has either the most or the least of just about everything. It is the simplest of the vinyl-type polymers but one of the last to be developed and the most difficult to produce. It has the most rapid growth curve (Figure 2) and may be the first billion pound plastic.

The equation for the polymerization of ethylene looks simple.

$$n CH_2 = CH_2 \rightarrow \left[\begin{array}{c} CH_2\,CH_2 \\ \diagup\diagdown\diagup\diagdown \\ CH_2\,CH_2 \end{array} \right]_n$$

The actual polymers have some branching and critical amounts of short and long chains. One of the problems of producing a desirable polyethylene is to achieve the desired degree of branching without the cross linking which prevents a smooth flow of the plastic. Light cross linking doesn't change flexibility or toughness appreciably but does impart non-melting and non-cracking features. This type of cross linking can be obtained by bombarding the polyethylene with high energy electrons.

The conditions used to polymerize ethylene are not typical for vinyl monomers in general but are much more extreme. The 99.8-percent pure ethylene is bulk polymerized with a small amount of oxygen as a catalyst at 15,000 to 30,000 psi and *ca.* 200 C. (Figure 1). The conversion is about 25 percent. Solvent polymerization is also used with an operating pressure of 15,000 psi and water, an aromatic hydrocarbon, or a mixture of the two as the solvent. Conversion by this method is about 17 percent. A recent polyethylene reported by Phillips Petroleum Company is made by a low pressure polymerization (less than 500 psi).

The uses of polyethylene are fast becoming legion and are not covered in this article. Figure 3 gives an indication of the estimated use pattern of polyethylene in 1953. The use of polyethylene pipes is increasing rapidly and more than 250 million squeeze bottles are predicted for 1954.

Polyethylene represents one of the most daring gambles in the petrochemical field.

Propylene is not polymerized extensively for the production of plastics but it is polymerized over a solid phosphoric acid catalyst to *propylene tetramer* for use in alkylating benzene. The resulting dodecylbenzene is sulfonated to produce a synthetic detergent. This type of detergent accounts for about 40 percent of all synthetic detergents.

Isobutylene is the only other strictly aliphatic olefin which is polymerized extensively for the production of plastic material other than synthetic rubber. The two general types of *polybutene* are the solid, rubber-like high polymer (molecular weight of 200,000) and a liquid polymer with a molecular weight of 10,000. The solid polymer is formed at —100 C., by solution polymerization with a boron trifluoride catalyst and ethylene as the solvent. The low polymer is formed in an isobutane solvent at about —10 C. The high polymer has properties and uses similar to butyl rubber (isobutylene plus a small amount of isoprene). Polybutenes are also used as viscosity improvers in lube oils, rubber modifiers, textile lubricants, adhesives and for the impregnation of leather.

Within the last 13 years the production of *styrene* ($C_6H_5CH = CH_2$) has increased from less than one million pounds to more than 800 million pounds. Much of this growth is accounted for by the concomitant increase in synthetic rubber production. *GR-S* rubber is a co-polymer of butadiene (75 percent) and styrene (25 percent). This use has leveled off during the past several years as *GR-S* production has been curtailed. *Polystyrene* production, the other important use of styrene, has not reached the predicted heights forecast in recent years but still presents a respectable figure (see Figure 4).

Styrene is polymerized by several different processes both by batch and continuous operation. In one batch Process, bulk polymerization is used at about 110 C., with benzoyl peroxide as the catalyst. The reaction is carried out to 60-70 percent completion and then the polymerization is completed in small molds at 160 C., to permit better temperature control. Pearl polymerization of styrene is becoming increasingly popular.

Two developments have kept polystyrene in the picture in spite of increased competition from many other polymers. The most important trend has been in the incorporation of rubbery co-polymers to improve the impact strength of the polystyrene. Modified and co-polymers of this type are used for high softening molding powders, ion exchange resins, styrenated alkyd finishes, styrenated epon resins, Stymer-type textile sizes and low-pressure laminating resins for glass fiber. For many of these uses styrene is running into competition from substituted styrenes such as vinyltoluene and vinylxylenes.

Foamed polystyrene is the other recent development of importance. Materials of this type are characterized by structural strength and very light weight. Foamed styrene is used for low temperature insulation, display pieces, toys, etc.

Synthetic Rubber

Nearly all rubbers are vinyl type plastics. Because of their special properties and extensive literature, they will not be discussed in this article.

End of Part 13. Part 14 will appear in an early issue.

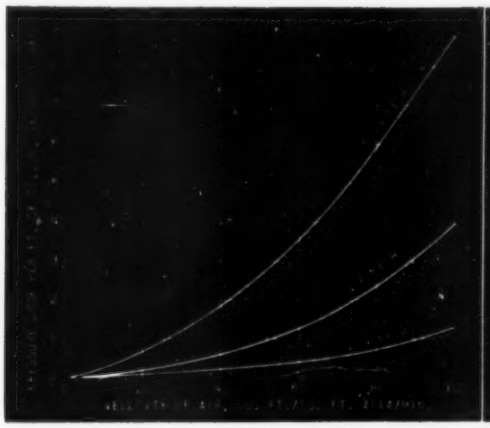

Figure 1. Pressure drop—air over activated alumina.[12]

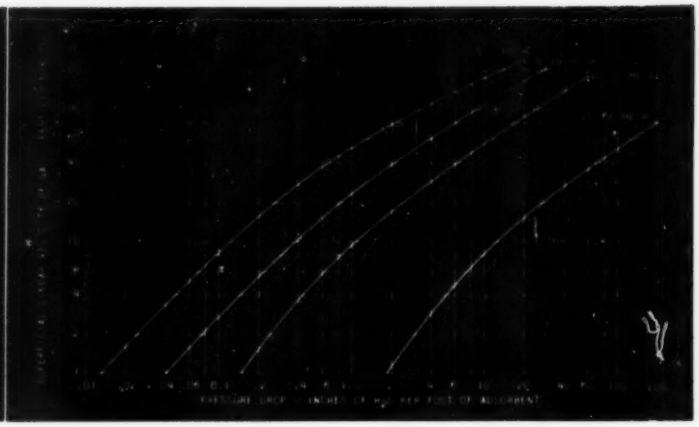

Figure 2. Pressure drop for gas flow through beds of granular adsorbents.[1]

Physical properties of . . .

Adsorbents and Catalysts

Authors summarize fundamental data, pressure drop, and drying data on the most common adsorbents and catalysts.

Felix Heinemann and Heinz Heinemann

EMPLOYMENT of adsorbents and catalysts in solid beds requires the availability of data on physical properties, so that the design engineer can determine capacities, pressure drops, bed temperatures, optimum particle size and much other vital information. A considerable volume of physical properties data has been published in the literature,[1-21] but almost every article is limited to one or two adsorbents and few correlations exist on the basis of identical dimensions. The present presentation is an attempt to gather some of the data which appeared to be of greatest interest to chemical engineers and chemists and which appear to have wide utility. While identical information frequently is not available for different adsorbents, much can often be gained by analogies.

Fundamental Data—Fundamental properties are discussed in Tables 1 and 2. Surface area, pore radius, percent voids and percent pores bear direct relation to adsorptive capacities and molecular size of substrate, while bulk, mercury and helium densities provide information on packing and liquid and gas volumes available in a tower. The effect of calcination temperature on some of the natural adsorbents is shown. Some thermal data are given in Table 2, along with the bulk weight.

Heats of wetting for water and some organic compounds are given in Table 3 for five adsorbents. Although the selection of compounds may appear

Table 1
Densities, Surface and Pore Properties of Adsorbents and Catalysts

ADSORBENT	Calcination or Activation Temp. °F.	D_B Bulk Density g/cc.	D_A Mercury Density g/cc.	D_T Helium Density g/cc.	Percent Voids[a]	Percent Pores[b]	Surface Area m^2/g	Average Pore Radius A°
Activated Alumina [9, 10]								
Grade F-1	400	.88	1.58	3.23	44	51	200	72
Grade H-151	400						300-350	
Bauxite: [9]								
Arkansas	450	1.33	2.02	2.54	44	20	27	76
	700	.97	1.68	3.18	43	64	236	33
	900	.95	1.63	3.21	42	49	178	34
	1300	.94	1.61	3.26	42	52	151	43
South American	900	.96	1.51	3.25	36	54	187	38
Silica Gel [6, 7, 9]	400	.78	1.32	2.12	41	38	602	10
Synthetic Silica-Alumina Gel [6, 7, 9]								
Fluid Catalyst	400	.82	1.38	2.25	41	39	374	15
Pelleted Catalyst A	400	.64	.97	2.37	34	58	372	33
Pelleted Catalyst B	400	1.00	1.56	2.37	36	34	280	16
Bead Catalyst	400	.79	1.14	2.38	30	52	420	22
Fuller's Earth [13, 8]	400	.56	1.01	2.56	44	60	126	95
(Attapulgite)	600	.55	.97	2.66			124	
	900	.54	.96	2.66	43	64	118	110
	1100	.56	.92	2.69	42	64	119	109
Bentonite	700	.68	1.140	2.65	41	57	260	38
Acid Activated	900	.67	1.130	2.66	41	57	236	43
	1300	.67	1.120	2.56	41	56	208	48
Diatomaceous Earth [6, 7]	400	.32	.63	2.27	49	44	4	5500
Activated Carbon [6, 7]								
Columbia Carbon		.42	.75	1.89	44	60	1397	12
Darco Carbon		.36	.73	2.09	51	66	560	32
Bone Char [2, 3]		.68		2.8	47	46	110	

a Percent Voids $= 100 \frac{V_V}{V_B}$, where $V_V = \frac{1}{D_B} - \frac{1}{D_A}$

b Percent Pores $= 100 \frac{V_P}{V_T + V_P}$, where $V_P = \frac{1}{D_A} - \frac{1}{D_T}$ and $V_T = \frac{1}{D_T}$

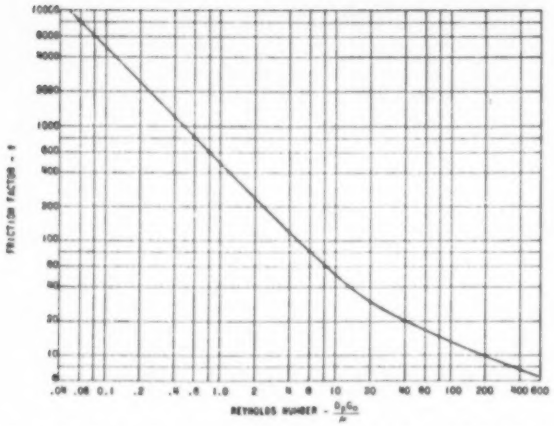

Figure 3. Friction factor vs. Reynolds Number for flow of fluids through beds of granular adsorbents.[1]

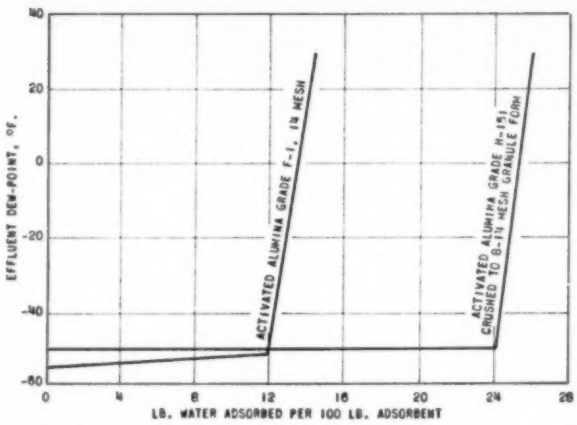
EFFLUENT DEW-POINT, °F.
ACTIVATED ALUMINA GRADE F-1, 1/8 MESH
ACTIVATED ALUMINA GRADE H-151 CRUSHED TO 8-14 MESH GRANULE FORM
LB. WATER ADSORBED PER 100 LB. ADSORBENT

Figure 4. Capacity for drying natural gas at 2000 psig, saturated with water at 80 F.[20]

arbitrary, the profound effect of different functional groups on the heat of wetting is very evident.

Pressure Drop Through Beds of Adsorbents—Proper calculation of pressure drop is one of the most important prerequisites of tower design. Height of bed, mesh size of adsorbent, viscosity of medium, velocity of flow are the major variables. Figure 1[12] gives pressure drops for a flow of air over activated alumina of different mesh sizes as a function of air velocity.

More extensive data for gas flow are presented in Figure 2.[1] A mathematical treatment for the flow of fluids through beds of granular adsorbents is shown in the insert box of Figure 3.[1] Pressure drop is expressed in terms of bed depth, particle diameter, superficial mass velocity, fluid density and friction factor. The graph shows the relationship between the friction factor and the Reynold Number (R_e), which in turn is defined by

$$R_e = \frac{D_p G_o}{M} \text{ where}$$

D_p is the effective particle diameter in feet

Table 2. Bulk Weight—Thermal Data

	Bulk Weight lbs./c ft.	Thermal Conductivity Btu/ft²/hr/°F/in.	Specific Heat Btu/lb/°F.	Heat of Wetting of Water cal/g at about 70 F.
Silica Gel	38-40	1	0.22	29.1
Silica-Alumina Cracking Catalyst	48-52	....	....	....
Activated Alumina Grade F-1 [18,19]	50	1.5	0.25	14.1[a]
Activated Bauxite (700 F.) [14]	61	....	0.25	19-21
Activated Fuller's Earth [14]	34	0.4	0.25	23.7
Acid Leached Bentonite	45	....	0.25	....
Bone Char [2,3]	38-42	0.1	0.24	15.9
Activated Carbon	25	....	....	9.5

[a] Grade x F-21.

Table 3. Heat of Wetting of Adsorbents cal/g.

	Activated (700 F.) Bauxite (Ark.)[14]	Activated (550 F.) Fuller's Earth[14]	Activated[14] Carbon	Silica[14] Gel	Activated Al_2O_3[18,19] (xF-21)
Water	21.8	23.2	9.5	29.1	18
Methanol	16.2	20.6	25.7	34.9	....
Ethanol	12.8	17.1	27.0	31.7	....
n-Propanol	12.6	15.9	26.5	29.2	....
n-Butanol	12.3	13.4	27.0	28.5	....
-Butanol	11.0	12.1	23.0	25.5	....
tert-Butanol	9.1	6.5	20.2	21.9	....
Acetone	10.1	17.9	....	....	....
Propionaldehyde	36.5	22.1	....	....	....
Benzene	5.4	4.3	....	....	....
Nitrobenzene	7.4	9.3	....	....	....
Aniline	11.9	9.7	....	....	....
Pyridine	11.0	....	....	....	....
n-Heptane	3.0	....	....	....	2.7
Tritane	....	....	....	....	2.6
Methylcyclohexane	....	....	....	....	4.7
Toluene	4.5	....	....	....	4.1

Table 4. Drying Capacities of Adsorbents
(For air of 75 percent humidity [at 80 F.] at 15 cft/hr/lb adsorbent to a dew point of —50 F. wt. percent of adsorbent)

Activation Temp., °F.	Silica Gel	SiO_2-Al_2O_3	Alumina Act. F-1	Alumina Act. H-151	Fuller's Earth	Activated Bauxite	Activated Bentonite
Optimum	19-21	18-20	13-15	20-24	13	12-13	13
400	....	....	....	....	12	1	13
500	....	....	....	....	13	1	11
600	....	....	....	....	13	9	10
700	....	....	....	....	8	12	8
800	....	....	....	....	5	11	7
900	....	....	....	....	5	8	7
1000	....	....	....	....	4	7	6
1100	....	....	....	....	4	7	6
1200	....	....	....	....	3	7	6
1300	....	....	....	....	3	6	5

Table 5
Effect of Mesh Size on Drying Capacity
(Dry Gas Capacity [10] Determined for Bauxite)

Mesh Size	Relative Capacity, Percent
10-20· 20-35	100
6-14	94
6-10	90
4-8	80

Effect of Relative Humidity of Air on Drying Capacity
(Determined for Bauxite)

Relative Humidity (80 F.), Percent	Relative Capacity, Percent
97	100
75	85
50	68
10	39

Effect of Air Velocity on Drying Capacity
(Determined for Bauxite)

Air Velocity cft/hr/lb	Relative Capacity Percent
10	100
15	97
20	85
25	69

Table 6
Decline of Sorptive Capacity with Time
Gel Type Adsorbents

	LBS. WATER ADSORBED/100 LBS. DESICCANT	
Effluent Dew Point, °F.	Initial	Levelled Out (Five and More Months)
—25	10-12	4-6
0	11-13	5-8
+10	12-14	6-9
+25	14-17	7-10

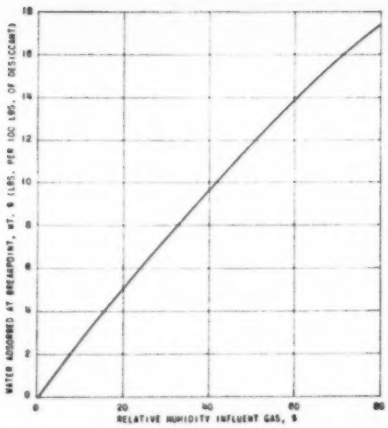

Figure 5. Effect of relative humidity on breakpoint capacity. (Bed depth, 30 inches; gas velocity, 80 feet per minute.)[17]

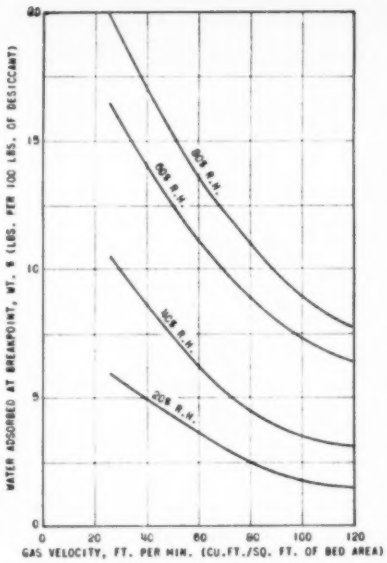
80% R.H.
60% R.H.
40% R.H.
20% R.H.
WATER ADSORBED AT BREAKPOINT, WT. % (LBS. PER 100 LBS. OF DESICCANT)
GAS VELOCITY, FT. PER MIN. (CU.FT./SQ. FT. OF BED AREA)

Figure 6. Effect of velocity on breakpoint capacity. (Bed depth, 15 inches.)[17]

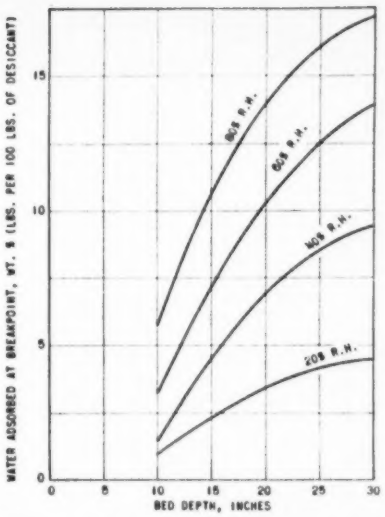

Figure 7. Effect of bed depth on breakpoint capacity. (Gas velocity, 85 feet per minute.)[17]

Go is the superficial mass velocity in lbs/ft² of tower cross section/second
M is the absolute viscosity in lbs/ft/sec.

Drying Data—The drying of gases and liquids is one of many large scale applications of adsorbents. It is of major interest to the petroleum and natural gas industry. The selection of the proper adsorbent for a commercial drying installation will depend on the degree of drying required, the capacity of the adsorbent at the drying conditions and its cost. Requirements usually are widely different for gas drying over stationary beds of adsorbents and for packaging desiccants.

The drying ability of an adsorbent can be measured by the amount of moisture it adsorbs prior to a break point at which the dew point of the dried gas passes a given value (dry gas capacity). The total amount of moisture which an adsorbent can pick up before it reaches an equilibrium state with the gas (equilibrium capacity) is also of importance, particularly for desiccants but will be treated in a later article. In Table 4 there are presented dry gas capacities of some adsorbents for air of 75 percent humidity at 80 F., drying at atmospheric pressure to a dew point of —59 F. The effect of activation temperature on the dry gas capacity of the natural adsorbents is also shown. Figure 4[20] shows break points in drying capacity for two grades of alumina at 2000 psig.

Other factors affecting the drying capacity at otherwise constant conditions are adsorbent mesh size, relative humidity of the gas, gas velocity and bed depth. Table 5 presents data on the first three of these factors for activated bauxite, while Figures 5, 6 and 7[17] illustrate the last three factors in their effect on silica-alumina gel.

It is well known that the sorptive capacity of adsorbents declines with time, as the adsorbent is subjected to frequent drying-regeneration cycles. Usually, the decline in activity is rapid during the initial cycles and tends to level off after some time. In Table 6 are given data on initial and levelled-off dry gas capacities of gel type adsorbents for several dew points.

Drying of liquids by adsorbent percolation has found widespread application. Drying of gasoline, for instance, is of great interest to refiners. The capacity of activated alumina to remove water from gasoline is demonstrated in Figure 8.[4] Factors such as flow rate and saturation will, of course, affect the drying capacity. These and data on equilibrium capacities and adsorbent drying of other liquids will be discussed in a later article.

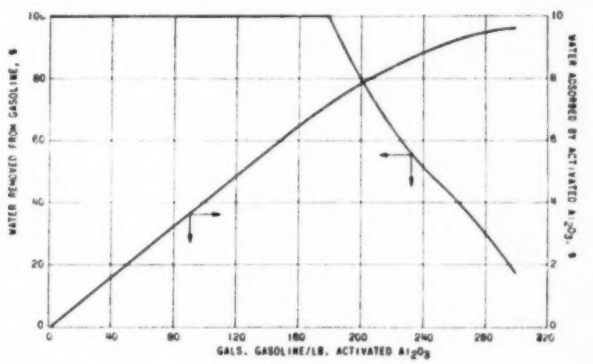

Figure 8. Drying of gasoline with activated Al_2O_3. (Flow, 80 gallons per hour per pound; saturation 0.0048 percent water.)[4]

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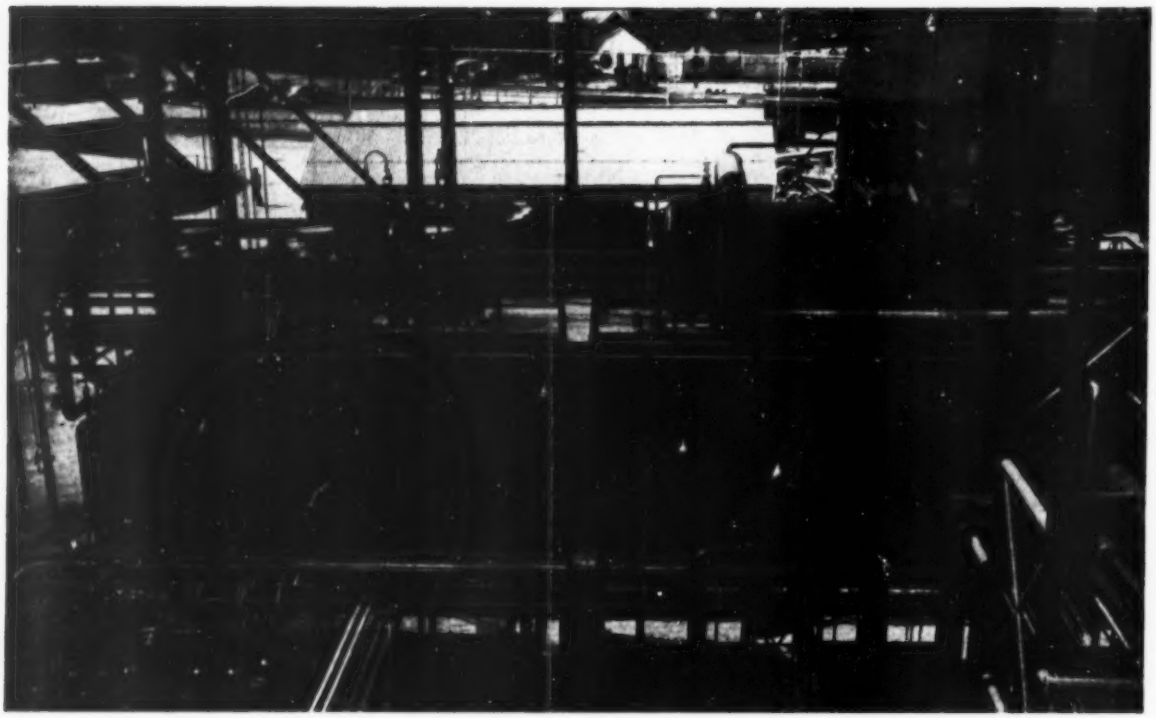

Cascade reactor: on stream after 101 days

Eastern States Adds Alkylation

New cascade-type reactor at refinery on Houston ship channel is biggest of its kind.

A NEW AVIATION gasoline refining unit producing 3000 barrels of fuel daily has gone into production at the Eastern States Petroleum Company, Inc., plant at Houston and was put "on stream" in the record time of 101 working days, or approximately four and one-half months total time.

Brown & Root, Inc., was the contractor, working in conjunction with Eastern States' refinery maintenance forces. The aviation gasoline produced will be sold to the armed services on a long-term contract, according to R. N. Blaize, executive vice president of Eastern States.

The new unit was designed and built by Brown & Root, Inc., using a Kellogg process. This unit is part of a $5 million expansion program which has been constructed in the past three years by Eastern States. The program includes a platforming unit, a benzene recovery unit and a solvent refining unit. The refinery is located on the Houston Ship Channel.

The new alkylation unit utilizes the new cascade type reactor. At the present time this reactor at Eastern States is the largest of is kind which has ever been put into service.

The light hydrocarbon feed for this unit is obtained from the gas concentration section of the cat cracker which fractionates gas streams from the thermal unit at Plant I and the Platformer and cat cracker at Plant II. Approximately 1200 barrels daily of iso-butane has been purchased to be used with the olefin feed from Eastern States sources to form the combined charge to the new unit.

Sulfuric acid used in the process unites the iso-butane with olefins to form alkylate which is the main constituent of aviation gasoline. The actual contact of the hydrocarbon streams with the acid takes place in a large horizontal reactor at a temperature of 35 F., and a pressure of 3 psig. The low temperature is maintained by flashing propane and iso-butane in the reactor and recycling through a refrigeration system.

The effluent is then fractionated to yield propane, butane, light alkylate, and heavy alkylate. The propane and butane will be sold for home consumption and the heavy alkylate will be further processed in the cat cracker. Aviation gasoline, grade 100/130, will be made from about 50 percent light alkylate and 50 percent products from the Platformer.

The auxiliary equipment added to the refinery as a result of the alkylation program are a 10,000 gpm cooling tower and cooling water system, a 100,000 pound per hour boiler, and iso-butane unloading rack, a 5000-barrel iso-pentane sphere, and several large tanks at Traweek Terminal for use as storage for finished aviation gasoline. A truck loading rack is being constructed to furnish aviation gasoline locally to the Air Force.

Applications of a method for . . .

Designing Fired Tubular Reactors

This is the second study on this important subject. Previously, the design method was developed, and here are the practical applications.

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IN PREVIOUS STUDIES, far more consideration has been given to the design of the usual auxiliary equipment of a chemical plant than to the design of, perhaps, the most basic unit, the chemical reactor. Of the many types of reactors used, a common one is the fired tubular reactor. The differential equations describing such a reactor have been stated,[1] where the development of an approximate solution to these equations was also given. The present discussion contains material on both the application of the approximate method to the design of reactors and how it can be used to predict the behavior of an existing reactor.

The approximate design method, as stated below, is applicable to fired tubular reactors in which an endothermic, first order, gas phase reaction occurs. As the term is used here, a fired tubular reactor consists essentially of straight tubes connected by return bends, most but not all of the straight portion of each tube being heated on its outside by flue gas. The tubes and return bends are assumed to be in series and equal in number. The unit upon which the calculations are based consists of one tube and one 180° return bend. The actual reactor is equivalent to a long, straight pipe of length $N \cdot (L_s + L_b)$, having a friction factor which takes into account the effect of the return bends. The actual heat input is also averaged over the single tube and return bend.

Statement of the Design Equations—Two sets of equations are stated below; one for the preheat and one for the reactor section. In the preheat section, the feed is heated to the threshold temperature at which the reaction begins to proceed at an appreciable rate. This section is arbitrarily defined as the volume required to obtain a conversion of one percent. Utilization of appropriate approximations, discussed previously,[1] lead to the following design equations for the preheat section:

$$p_0^2 - p_1^2 = \frac{\beta}{m}(T_1^2 - T_0^2) \qquad (1)$$

$$V_r = \frac{T_1 - T_0}{m} = \frac{t_1 - t_0}{m} \qquad (2)$$

$$N_{Preheat} = \frac{wc_p}{\pi D_i q_s} \cdot \frac{(t_1 - t_0)}{L_b} \qquad (3)$$

$$k_1 T_1^2 = 0.04 \frac{E}{R} \frac{q}{D_i M_0 c_p y_{A0} p_1} \qquad (4)$$

In the reactor section, where all but one percent of the reaction occurs, the design equations are

$$\phi\left(p_2 \cdot \sqrt{\frac{b_2 m}{2a}}\right) = S \frac{(1+\delta X_2) - (1+\delta y_{A0}) \cdot \psi[b_2 s(y_{A0} - X_2)]}{y_{A0} - X_2} \qquad (5)$$

where ϕ = function shown in Figure (2) of Reference 1.

ψ = function shown in Figure (3) of Reference 1.

$$S = \frac{4q}{k_2 \cdot (\Delta H_r) D_i} \sqrt{\frac{b_2 m}{2a}}$$

$$p_1^2 - p_2^2 = \frac{2a}{m}(t_2 - t_1 + sX_2) \qquad (6)$$

$$V_{r_2} - V_{r_1} = \frac{t_2 - t_1 + sX_2}{m} \qquad (7)$$

In order for the equations to be valid, it is necessary that X_2 be equal to or greater than $4/(b_2 s)$, that t_2 be greater than t_1, and that p_2 be at least one-fourth of p_1. It is also necessary that specific heat, heat of reaction, friction factor, compressibility factor, and molal expansion (δ) not vary greatly over one section of the reactor, so that average values of these quantities may be used as mean values.

Illustrative Examples

Example No. 1: This example is similar to the one considered before.[1] Previously, the final pressure and conversion were set, and the corresponding reactor diameter and heat input rates calculated; whereas, in the present example, the situation is reversed. A brief statement of the problem follows.

The reaction $A \rightarrow 2B$ is to be carried out in a fired tubular reactor. The rate of the reaction is kp_A. The design conditions are as follows: $y_{A0} = 0.95$, $w = 8000$ lb/hr, $T_0 = 600$ F., $p_0 = 100$ psia, $T_2 = 1300$ F., $D_i = 0.280$ ft. (3.36 inches), $q_{Preheat\ Sect.} = 6000$ Btu/(hr.) (sq. ft. inside area), and $q_{Preheat\ Sect.} = 11000$ Btu/(hr.) (sq. ft. inside area). The physical properties, which for this example will be considered constant, are as follows: $c_p = 0.75$ Btu/(lb.) (°F.), $k = 4 \times 10^{11} e^{\frac{-46500}{T}}$ (lb. mole)/(hr.) (ft.^{3}) (psi). (In this expression, T is in °R.), E/R = 46500°R, $M_0 = 60$, $\Delta H_r = 36000$ Btu/(lb. mole A reacted), $\mu = 0.02$ centipoise, $Z = 1$, and $Bf° = 0.072$. Determine both the pressure and the conversion at the reactor outlet as well as the volumes needed for the preheat and reaction sections.

Solution for Example No. 1

1. Determination of t_1, p_1 and V_{r_1}

By Equation (4)

$$k_1 T_1^2 = 0.04 \times 46500 \times \frac{6000}{0.280 \times 60 \times 0.75 \times 0.95 \times 100} = 9320$$

By trial, $t_1 = 988$ F. For simplicity, $t_1 = 990$ F.

$\beta = 0.0279$, from its definition

$$(m)_{Preheat} = \frac{4 \times 6000}{0.280 \times 8000 \times 0.75} = 14.28$$

By Equation (1)

Dr. Murdoch's present address is in care of The Dow Chemical Company, Freeport, Texas.

$$p_1^2 = 100^2 - \frac{0.0279}{14.28}(1450^2 - 1060^2);$$

$p_1 = 89.93$ psia

By Equation (2)

$$(V_r)_{Preheat} = \frac{990 - 600}{14.28} = 27.3 \text{ ft.}^3$$

2. Determination of p_2 and X_2.

To do this, assume X_2, evaluate parameters β, a, m, s, and b_2, and calculate p_2 by both Equation (5) and Equation (6). Repeat for two other assumed values of X_2, and plot p_2 vs. X_2 for each Equation. The correct p_2 and X_2 are obtained by the intersection of the curves. The calculation of p_2 for one point on each curve is as follows:

X_2 assumed $= 0.85$; $\beta = 0.0279$, $a = 64.2$, $s = 800.0$, $(m)_{Reactor} = 26.19$,

$$\sqrt{\frac{b_2 m}{2a}} = 0.0553, \quad S = 0.180,$$

$b_2 s(y_{A0} - X_2) = 1.20$, $\psi(1.20) = 0.370$.*

Substitution of numerical values in Equation (5) gives

$\phi(0.0553\ p_2) = 2.03$; then $0.0553\ p_2 = 1.756^*$, $p_2 = 31.8$ psia.

Substitution of numerical values in Equation (6) gives $p_2 = 56.9$ psia.

The curves intersect at $X_2 = 0.896$, $p_2 = 54.0$ psia. Then from Equation (7), $(V_r)_{Reactor} = 39.2$ ft^3. Length of tubes plus bends = 444 ft. in preheat section, 637 ft. in the reaction section.

Comparison With Forward Stepwise Calculation.

Myers and Watson[2] investigated the pyrolysis of propane, and proposed a group of reactions and corresponding reaction rates to explain their data. Using these rates they integrated stepwise the differential equations of design, for a special numerical case. In the present section their data for the Preheat and Reaction Sections will be compared with those obtained by use of the approximate method outlined above. In their problem, these two sections were followed by a soaking section, assumed to be held at constant temperature by appropriate point to point variation of q. The approximate design method can be extended with little difficulty to include an isothermal or soaking section, but since this section is seldom necessary, the extension is not given here. The problem to be studied is as follows:

Example No. 2: It is desired to pyrolyse, in a direct-fired tubular reactor, 7455 lb/hr of pure propane. The tube inside diameter is 4.5 inches, the inlet pressure is 70 psia, and the heat input rate is 8000 Btu/(hr) (ft^2) throughout, based on the internal area of the heated portion of the tubes. The tubes are each 30 feet long, and are connected by 180° return bends; only 28 feet of each tube is in the heated portion of the furnace. What are the pressure and conversion at the point in the reactor where the temperature of the reacting mixture is 1350 F., and the same at 1400 F.?

The kinetics and values of physical properties used by Myers and Watson will be employed, so that the comparison between the methods will be valid.

The properties of the system that are involved in the calculations are c_p, μ, δ, f°, k, M_0, ΔH_r and Z. M_0 is 44.09; following Myers and Watson, Z is taken to be unity and f° to be 0.0636. Myers and Watson give a plot showing viscosity versus temperature, and specific heat versus temperature with conversion of propane as parameter, and also give the rate constant and heat of each reaction occurring in the system, as functions of temperature. In applying the calculational method described in the present paper, it is important to choose the proper mean values of the various physical properties of the system. The following means are used:

For μ, f°, and Z: arithmetic average of values at ends of the reactor section to be calculated.

Molal expansion, δ:

$$\frac{(\text{Total moles flowing at reactor outlet}) - (\text{Moles feed to reactor})}{\text{Moles propane reacted at reactor outlet}}$$

Specific heat, c_p: For the reaction section: Mean c_p for feed (propane, here) between t_1 and t_2. The c_p for propane is used to obtain the proper heat balance in conjunction with the ΔH_r used. For the preheat section:

c_p of feed at $t = t_1 - \frac{1}{b_1}$

(This value is readily shown to be correct by integration of the differential equation leading to Equation (4) where it is assumed that c_p varies linearly with temperature and that pressure varies only slightly in this section.)

Heat of reaction, ΔH_r: Unless there is a large variation in ΔH_r within the reaction section, use the mean value over the interval O to X_2, evaluated at t_2: $(\Delta H_r)_m$. That is $\Delta H_r = (\Delta H_r)_m =$

$$\frac{(\text{Enthalpy of effluent})_{at\ t_2} - (\text{Enthalpy of feed})_{at\ t_2}}{\text{Moles propane reacted at reactor outlet}}$$

If variation in ΔH_r is large, a corrected ΔH_r must be used, as discussed below.

The results of calculation by the approximate method were compared with those obtained by numerical, stepwise integration of the several applicable differential equations. Two types of numerical integration were involved. The first was made to check the accuracy of the method for a one-reaction, constant ΔH_r system. For this purpose the rate of the reaction was taken to be that of propane disappearance by the sum of Myers and Watson's four primary reactions. ΔH_r and δ were taken to be constant at their mean values at the end of the reaction section, namely, 37400 Btu/lb mole propane reacted and 0.91, respectively. The method of calculation was substantially that of Example No. 1, above. The results were as shown in Table 1.

Check on validity of equations for reaction section, at $t_2 = 1350$ F.:

$b_2 s = 0.01829 \times 920 = 16.83$; $\frac{4}{b_2 s} = 0.24$. $X_2 = 0.58$, and therefore

$X_2 > \frac{4}{b_2 s}$. Also, $t_2 > t_1$. $p_1/4 = 15.7$; therefore $p_2 > (p_1/4)$.

At 1400 F. the conditions for conversion and temperature are obviously satisfied. For pressure: $p_2 > 15.7$.

Therefore, all conditions are satisfied for either outlet temperature.

In making the calculation, the following numerical values were used:

$L_h = 28.0$ ft., $L_a = 30.0$ ft., $D_i = 0.375$ ft., $q = 8000 \times 28.0/(30.0 + 4 \times 0.375) = 7111$ Btu/(hr) (ft^2).

$B = (30.0 + 60 \times 0.375)/(30.0 + 4 \times 0.375) = 1.667$, $E/R = 54490°$ R,

$b_2 = 0.01732$ at 1400 F. (0.01829 at 1350 F.),

$k_2 = 0.3356$ (lb mole)/(hr) (ft^3) (psi) at 1400 F. (0.1360 at 1350 F.); f° = 0.0636,

$\beta = 0.00593\ (100\mu)^{0.2}$.

$M_0 = 44.09$, w = 7455 lb/hr., c_p = mean for pure propane, Z = 1.0.

The agreement is seen to be good, indicating that the calculational method (when used with the indicated mean values of the physical properties involved) is of satisfactory accuracy.

Additional consideration must be given to the selection of the value of ΔH_r to be used, since this variable was arbitrarily taken to be constant in the above example. The variation in the heat of a single reaction is seldom large within the reaction section, but the occurrence of several simultaneous reactions (as in a pyrolysis) may lead to a considerable variation in the value of ΔH_r to be used in the equations.

Nevertheless, the heats of the reactions preponderating in the forepart of the section may differ widely from those of the reactions occurring mainly in the afterpart. If this is so, the absorption of heat per mole of reactant

* Plots of the ϕ and ψ functions are shown in Figures (2) and (3), respectively, of Reference 1.

reacted must depend sharply on the conversion. Although such ΔH_r variation is not great in ordinary hydrocarbon pyrolyses, a comparison of the approximate method with a detailed numerical integration for a case with large variation is desirable.

Example No. 3: An example where the heat of reaction varies considerably with conversion was set up by arbitrarily reversing the sign of the heat of one of the reactions (No. 8) assumed by Myers and Watson to occur during propane pyrolysis, but including all ten of their reactions in the numerical integration. It happens that this reversal of sign causes ΔH_r to vary much more with conversion than in the actual case. The magnitudes of the values of $(\Delta H_r)_m$ for the combined reactions are indicated by Table 2.

TABLE 2

Mean Heat of Reaction,* $(\Delta H_r)_m$, (Btu Absorbed)/(lb mole propane reacted)

Conversion of Propane, X	ACTUAL Mean Between X=0 and X=X, $(\Delta H_r)_m$	WITH SIGN OF $(\Delta H_r)_8$ REVERSED	
		Mean Between 0 and X, $(\Delta H_r)_m$	Differential** at X, $(\Delta H_r)_d$
0.0	42900	42000	42000
0.50	41600	38000	32900
0.70	39200	35700	26400
0.80	38200	34400	22100
0.86	37400	33300	.....

* Evaluated at the temperature at which conversion = X in the reactor.

** $(\Delta H_r)_d = \dfrac{d[X(\Delta H_r)_m]}{dX}$

The ΔH_r variation shown is the result almost entirely of changes of relative rates of the various reactions occurring in the reactor. Such rate changes are caused by progressive increase of X through the reactor. Temperature level as such has only a minor effect on ΔH_r.

Comparison with numerical integration showed that the approximate method in the form used above was in error by several percent at 1400 F., because of the exceptional variation in the heat of reaction. It was, however, found that for this example, agreement satisfactory for most purposes could be obtained by using the following ΔH_r values: In the evaluation of s, take $\Delta H_r = (\Delta H_r)_m$, and in the evaluation of S, take

$\Delta H_r = (\Delta H_r)_m - d \cdot \forall\psi[b_2 s(y_{A0} - x_2)]$

where $d = (\Delta H_r)_m - (\Delta H_r)_d$.

In the case of s, the mean value of ΔH_r suggested is exact when the effect of temperature is negligible; whereas for S, the mean value suggested is semi-theoretical. Equation (5) thus becomes

$$\phi\left(p_2\sqrt{\frac{b_2 m}{2a}}\right) = S'.$$

$$\frac{(1+\delta X_2) - (1+\delta y_{A0})\,\psi[b_2 s(y_{A0} - X_2)]}{(y_{A0} - X_2)} \qquad (8)$$

with $S' =$

$$\frac{4q}{k_2 D_t} \cdot \frac{\sqrt{\frac{b_2 m}{2a}}}{(\Delta H_r)_m - d \cdot \forall\psi[b_2 s(y_{A0} - x_2)]},$$

but in Equations (6) and (7), $(\Delta H_r)_m$ must be used. In all other respects, the calculations by the approximate method were the same as those in which ΔH_r was assumed constant and equal to $(\Delta H_r)_m$ in all equations. The increase in complexity of calculation was negligible. In this manner results as shown in Table 3 were obtained.

TABLE 3

Temperature, t_2	1350 F.		1400 F.	
	Approx. Method	Detailed Numerical Integration	Approx. Method	Detailed Numerical Integration
Pressure, p_2, psia	45.0	45.1	36.9	37
Conversion, $100X_2$, percent	56.0	56.3	75.1	73.9
Number of Tubes				
Preheat Sect.	15.5	16.0	15.5	16.0
Reaction Sect.	17.5	17.1	22.4	21.8
Total	33.0	33.1	37.9	37.8

The calculations for the preheat section were identical with those already given.

Discussion — The approximate method is of good accuracy when it is applied to single, endothermic, gas phase reactions, and when the conditions for validity are satisfied. Its use is advantageous in two respects: it shortens the time required for calculation and (because of the relatively few steps involved) it decreases greatly the likelihood of numerical error as compared with stepwise integration. The approximate method is especially advantageous when both inlet and outlet conditions are fixed, a case which would require very lengthy stepwise calculations. If extensive plant data for the same reaction are available, the approximate method may, of course, not be needed. When the heat of reaction varies greatly over the reaction section, the method must be used with caution, although the calculations reported indicate that suitable correction for such variation can be made. The suggested correction adds very little to the labor of calculation.

TABLE 1

	APPROXIMATE METHOD		NUMERICAL INTEGRATION	
t_1, °F.	1194		1204	
p_1, psia	62.8		62.3	
	t_2 = 1350 F.	t_2 = 1400 F.	t_2 = 1350 F.	t_2 = 1400 F.
p_2, psia	44.5	33.6	44.3	33.1
100 X_2, percent conv.	58.0	77.6	58.7	77.6
Number of Tubes				
Preheat Sect.	15.5	15.5	16.0	16.0
Reaction Sect.	18.0	24.1	17.7	23.5
Total	33.5	39.6	33.7	39.5

The time required to make a design or performance calculation by the approximate method is much less than that needed for a stepwise calculation, even when the latter is of the "short-cut" type.

The examples illustrate aspects of the behavior of a first order reaction, when it occurs in a reactor having constant heat input rates over the separate sections. The equations can be used in ways other than those shown. It is possible to apply them to a reactor having two reaction sections, at different levels of heat input rate, provided that the conversion in each is such that the conditions for validity are met. As already mentioned, it is possible to use the equations readily in conjunction with corresponding equations for a soaking section. Furthermore, it is possible to derive analogous equations for reactions occurring with a second order or zero order rate.

If it is desired to make several designs, based on different operating conditions, the equations of the analytical method are readily applied to this situation. After having made the first design, the corresponding values for the second are readily obtained from the ratios of the design equations for the two sets of design conditions. For example, suppose a reactor has been designed for a given set of values of t_1, p_1, t_2, p_2, X_2, and w, the effect of changing w (the other quantities and feed composition remaining constant) on the design of the reaction section is given by the following relations:

$\dfrac{D_t}{D_t^{0.167}}$ is proportional to $w^{0.412}$

Did you miss the first article on this same subject? It appeared in *Petroleum REFINER*, March, 1954.

q is proportional to D_i,
$(V_r)_{\text{Reaction Sect.}}$ is proportional to w.

The corresponding relations for the preheat section are of the same form. The first of the above equations can readily be solved by simple trial to give D_i. Since B is ordinarily of the order of 1.3 to 2, the maximum value of the corresponding term in

$$D_2 = D_1 \left(\frac{B_2}{B_1}\right)^{0.167} \left(\frac{w_2}{w_1}\right)^{0.402}$$

is 1.067, where the subscripts 1 and 2 refer to the two design conditions. The trial involved is thus reduced by the small dependence of D_i on B.

A common problem is that of determining the changes in operating variables necessary to hold a given conversion, when the feed rate to an existing reactor is changed. Suppose that t_1, t_2 and X_2 are to be held constant (D_i and the volume of the reactor, of course, being constant). The equations show that in order to do so, the changes in heat input rate and the pressures must be as follows for the reaction section:

q is proportional to w

$\sqrt{\frac{b_2 m}{2a}}$ is proportional to $w^{-0.9}$

$\phi\left(p_2\sqrt{\frac{b_2 m}{2a}}\right)$ is proportional to $w^{0.1}$

$p_1^2 - p_2^2$ is proportional to $w^{1.8}$

The same relation for q and $p_0^2 - p_1^2$ hold for the preheat section; in addition, X_1 is proportional to $\frac{p_2}{w}$. These relations are readily used for an operating case. It is of interest to note the forms assumed by the third and fourth of the above relations when the outlet pressure, p_2, is not small (i.e. when $p_2\sqrt{\frac{b_2 m}{2a}}$ is 2 or more). In this case $\phi\left(p_2\sqrt{\frac{b_2 m}{2a}}\right)$ is approximately equal to $p_2\sqrt{\frac{b_2 m}{2a}}$. Then both p_1 and p_2 are nearly proportional to w, and X_1 is independent of w.

The friction factor has a very important effect on the behavior of a reactor, and is sometimes of critical importance. Coking has a double effect on behavior, in that it reduces the effective diameter of the tube and also influences the friction factor. Design should be made with due allowance for coking; usually, this cannot be done accurately for a reaction not already tested in the plant. For this reason, it is believed that the inaccuracy of the approximate method is, in many cases, less than that introduced by uncertainty in data. In addition, this method avoids the cumulative errors to which stepwise, numerical integrations are subject.[4]

ACKNOWLEDGMENT

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Nomenclature

a Pressure drop coefficient; $a = \beta\left[\frac{(T_1+T_2)}{2}\left(1+\frac{\delta X_2}{2}\right) + \frac{T_2-T_1}{12}\delta X_2\right]$, evaluated at the Reaction Section conditions.

b E/RT_2; i.e., $d \ln k/dT$, $°R^{-1}$.

B Pressure drop factor accounting for effect of return bends, dimensionless; $B = \frac{L_{ep}}{L_s + L_b}$; it is customary to take $L_b = 4\ D_i$ and $L_{ep} = L_s + 60\ D_i$.

c_p Specific heat, Btu/(lb) (°F).

D_i Inside diameter of tube, ft.

E Activation energy of reaction; i.e., $-d \ln k/d\ (1/RT)$, Btu/(lb. mole).

$f°$ Coefficient in friction factor; $f = f°.\ (\text{Reynolds No.})^{-0.2}$, dimensionless.

ΔH_r Heat absorbed by reaction of one mole of reactant, Btu/(lb. mole reacted. $(\Delta H_r)_d = \frac{d[X\ (\Delta H_r)_m]}{dX}$, $(\Delta H_r)_m$ = mean ΔH_r between O and X.

k Reaction rate constant. (Except where noted $k = k_p$, (lb. mole)/(hr.) (cu. ft.) (lb./sq. in.).

L Length of tube or indicated portion thereof, ft.

m $\frac{4q}{D_i w c_p}$, coefficient in several of equations stated, °F/cu. ft., may have different values in each section.

M Molecular weight; M_o = mean molecular weight of reactor feed.

n_{to} Total moles feed flowing per unit time, (lb. moles)/hr., $= w/M_o$.

N Number of tubes in series.

N_{Re} Reynolds number, dimensionless.

p Pressure, psia.; p_A = partial pressure of component A.

q Heat input rate, Btu/(hr.) (sq. ft. inside area of tube + return bend), q_a = Actual heat input rate, Btu/(hr.) (sq. ft. inside area of heated part of tube); $q = q_a \frac{L_h}{L_s + L_b}$

r Reaction rate, (lb. mole)/(hr.) (cu. ft.). 1

R Gas constant, Btu/(lb. mole) (°F). R_g = gas constant (PVT units) = 10.73 (lb./sq. in.) (cu. ft.)/(lb. mole) (°R).

s $\frac{\Delta H_r}{M_o c_p}$, coefficient in Equations (5) through (7), °F.

S Coefficient in Equation (5), dimensionless.

S' Coefficient in Equation (8), dimensionless.

T,t Temperature in °R, °F, respectively.

V_r Inside volume of reaction space; i.e., of tubes plus return bends, cu. ft.

w Feed rate (total) to reactor, lb./hr.; $w = M_o n_{to}$.

X [Moles reactant (A) reacted per hour, between inlet and a point in the reactor] ÷ [Mole total feet to reactor, per hour] = Conversion at that point, dimensionless.

y Mole fraction in gas, dimensionless; y_{Ao} = mole fraction of reactant (A) in reactor feed.

Z Compressibility factor of gas, dimensionless.

β $\frac{41.2}{M_o} \cdot \frac{ZB f°}{6.8(6D_i)}\left(\frac{w}{1000}\right)^{1.8}\left(\frac{1}{\mu}\right)^{0.2}$, (psi)² / (ft.)³ (°R); coefficient in Equation (1), also involved in the definition to a; may have different values in the Preheat and Reaction Sections.

δ Increase in total moles per mole reactant (A) reacted, dimensionless. In reaction $A = cC$, $\delta = c - 1$.

μ Viscosity, in centipoise.

ϕ Function of dimensionless pressure group, in Equation (5).

ψ Function of dimensionless conversion group, in Equation (5).

Subscripts.

0, 1, 2 Refer to inlet, end of preheat section, and end of reaction section of reactor, respectively.

a Actual.

A Reactant.

b Return bend.

ep Equivalent for pressure drop.

h Heated.

i Inside tube.

s Straight.

Check this . . .

Experience with Amine Units

These ten design hints and five operating hints can cut corrosions, amine losses and upsets.

R. A. Feagan, H. L. Lawler and M. H. Rahmes,
Stanolind Oil & Gas Company, Tulsa

IN SPITE OF THE relatively long time that amine units have seen commercial application—and in spite of a substantial research effort by the users, plant designers and manufacturers of amines and alloys—amine units continue to be a source of trouble and expense to many operators.

Tentative conclusions our company has reached regarding design and operation of amine units are based on four to five years' experience operating five H_2S removal units with aqueous monoethanolamine and on study of the experiences of other companies in this field. These conclusions regarding aqueous amine unit design and operation are tentative since all variables have not been sufficiently explored.

During 1953, the five H_2S removal units under discussion processed gas at a total average rate of 205.3 million cubic feet daily, and extracted acid gas (H_2S and CO_2) at a total average rate of 10.6 million cubic feet daily at a total cost (not including utilities, amortization, or overhead) of $808 per day, or about $76 per million cubic feet of acid gas extracted. This expense can be roughly broken down as follows: maintenance, repairs, etc., 50 percent; chemicals (primarily amine), 31 percent; and operating labor, 19 percent. Thus, the problems are, in the order of their importance, corrosion, amine losses, and frequency of operating upsets (such as foaming, failure to sweeten gas, etc.) calling for more operator attention and, consequently, higher operating labor costs.

The average gas processed by the five units during 1953 ranged from 8.8 to 88.7 million cubic feet, acid gas removed ranged from an average of 0.33 to an average of 7.28 million cubic feet daily, and total average operating cost ranged between $19 and $298 per million cubic feet of acid gas removed. Design amine circulating rate for the five plants ranges between 97 and 1515 gpm, and design gas handling capacity between 12 and 120 million cubic feet daily, design acid gas content between 0.9 and 24.5 percent of the inlet gas. The units were designed and built by several different contractors; two of the plants feature "split flow" regeneration and one of these two is designed for "pressure" regeneration.

Costs mentioned above are substantially lower than those experienced during the early period of operation of these plants because of the numerous changes in design and operation made in some of the plants since start-up. Some of the costs reflect substantial expenditures for major repairs or revisions.

Corrosion has been experienced primarily in the reactivator reboilers, reactivators, solution pumps, heat exchangers and related piping. Reboiler life has ranged from two months to more than one year in the same plant, with the improvement credited to changes in design and operating practices. Carbon steel reboilers in other plants have lasted several years. One carbon steel reactivator tower has been completely replaced, and two others repaired and modified after bubble cap trays were corroded away. A number of heat exchanger bundles have required repair or replacement while others have not failed to date.

All of the plants have experienced corrosion to some extent but, to date the cost of corrosion in two of the plants has been small.

Amine losses have varied widely, foaming has been experienced at times, and there have been a few times that difficulty has been experienced in meeting sales gas specifications.

Conclusions and recommendations resulting from experience with these five plants plus a short discussion of each follow. As is so often the case, there must be a compromise, or economic balance, between initial investment and operating and maintenance costs. The authors do not have the data to draw this line precisely.

Some of the following suggestions may seem obvious but they are included to make the list as complete as possible.

For convenience, the recommendations are divided into two groups, (1) those which must be considered by the plant designer, and (2) suggestions for the plant operator.

The designer should:

1. Provide Sufficient Capacity to Permit Operating with Low Amine Concentrations—Experience in the five plants discussed above has indicated a correlation between loading on the unit and corrosion troubles. The plants experiencing the least amount of corrosion have sufficient solution circulating capacity to permit satisfactory gas sweetening with amine concentration in the order of eight to ten percent. While it might not be economical to design a unit for such low solution concentration, it is recommended that a design concentration of 15 percent MEA be used rather than the twenty to thirty percent often proposed by investment-cost-conscious designers.

2. Avoid Excessive Reboiler Heating Medium Temperatures—If steam is used for heating, excessive temperature is not usually a problem although there are indications that reboilers designed for relatively low heat flux, i.e., low pressure steam in the order of 50 to 75 psig, might have longer life than reboilers using high pressure steam. If other heat medium is used, such as hot oil, experience has shown that the problem can be critical. Both carbon steel and stainless steel reboiler bundles have failed in about two months when heated by oil entering at approximately 550 F. If hot oil is used, it is believed that the maximum temperature should be restricted to about 400 F. in an effort to limit amine film temperature. It should be recognized that even minor leaks may cause difficulties resulting from contamination of the solution by oil.

3. Avoid Use of Dissimilar Metals—This applies particularly to regenerators and reboilers. Certain critical regenerator internals were constructed of stainless steel in one of the plants mentioned above. This caused serious bimetallic corrosion of the carbon steel at the point of contact. The same phenomenon has been experi-

enced in hot amine lines (carbon steel) where some of the fittings were carbon-moly steel.

4. Give Consideration to Packed and Lined Regenerators Rather Than Bubble Tray Towers—After encountering serious corrosion in several carbon steel towers equipped with carbon steel bubble trays, several of the regenerators in the five plants have been revamped, bubble cap trays removed, the regenerators lined with a two-inch sprayed cement mixture, and Raschig rings installed to replace the bubble cap trays. This system has proven satisfactory and has been adopted for new plant design.

5. Provide a Suitable Amine Reclaimer—This is a small batch still operating on a slip stream amounting to ½ to 1 percent of the design circulation rate. Its purpose is to remove from the circulating amine soluble but nonvolatile impurities such as decomposition and oxidation products of amine which are thought to contribute to corrosion. Usually a small amount of soda ash is added either directly to the reclaimer or to the circulating solution to accomplish more complete recovery of amine in the redistillation operation. Our experience indicates that amine redistillation is an important step in reducing corrosion. Decomposition of amine in the circulating system can be shown by comparing the results of several methods of analyses. Acid titration determines the total alkalinity, the Van Slyke indicates the primary amine group, and the Kjeldahl determines total nitrogen. All of these methods will give essentially identical MEA contents on a fresh solution. When decomposition begins or some reaction ties up or destroys the primary amine group, determinations by the three methods will begin to diverge. Another test used to indicate the corrosiveness of amine solution is the so-called "iron capacity test." In this test, the amine to be tested is contacted under certain specified and controlled conditions with powered iron. The amount of iron dissolved is reported in parts per million. To illustrate the effectiveness of amine reclaimers, results of tests on overhead and bottom streams from one reclaimer are shown by Table 1.

6. Provide an Effective Filter—In spite of all normal precautions, some corrosion takes place in amine systems. Corrosion products are in the circulating solution in the form of finely divided iron sulfide. This sludge has caused fouling of heat exchanger surfaces, plugging of some valves and lines, erosion of metal surfaces and even plugging of the regenerator and contactor columns. Several types of filters have been tested. It has been concluded that the precoated type filter using diatomaceous filter aid, although more expensive, is most satisfactory. It ordinarily operates on a slip stream from the hot rich amine to the regenerator.

7. Stress Relieve Major Equipment—Stress relieving adds relatively little to the cost of equipment. Experience has shown that stress cracking is likely to occur in amine units, particularly where hot amine comes in contact with carbon steel that is not stress relieved. Some stress corrosion has been reported even in amine contactors. Consequently, the practice has been adopted of stress relieving all major items of equipment.

8. Design for Lower Reactivator Operating Pressure—Many amine units have been designed for "pressure regeneration" because higher operating pressure, in the range of 30 to 50 psig, increases the bottom temperature of the regenerator and is believed to result in more complete stripping of the solution, particularly with respect to CO_2. This improvement in stripping should permit designing for a larger acid gas pickup per gallon of solution circulated, therefore reducing the design circulation rate. While experience is conflicting in this regard, there are indications that higher reactivator operating pressure increases reboiler, exchanger and regenerator tower corrosion. Consequently, the practice has been adopted of designing for minimum reactivator pressure, the lower limit being set usually either by the pressure required to supply the acid gas to a sulfur plant or by the pressure required to force amine out of the regenerator through heat exchangers to a surge drum or pump suction.

9. Provide an Efficient Inlet Scrubber to Prevent Liquid Hydrocarbon From Entering the Amine Contactor.

10. Design for Low Solution Losses—Experience has shown that excessive solution losses are due to mechanical leakage or to amine entrainment; therefore, solution pumps should be equipped with efficient mechanical seals, an efficient residue gas scrubber should be provided to recover amine entrained from the contactor, one or two water wash trays should be provided in the top section of the contactor and provision should be made to collect and reclaim any solution drained from equipment.

TABLE 1

DETERMINATION	Feed	Bottoms	Overhead
Acid Titration, as Percent MEA	17.5	45.1	19.5
Van Slyke, as Percent MEA	14.5	29.6	17.0
Kjeldahl, as Percent MEA	17.4	71.3	21.0
Iron Capacity, ppm	47	1204	4

All designers know that even a well designed plant will not be satisfactory with careless or improper operation. In addition to following the more obvious measures to assure sweet gas, the operator should:

(1) Use lowest amine solution strength which will give consistently sweet gas under the load conditions prevailing. This will reduce corrosiveness of the solution and will also reduce amine losses.

(2) Establish and maintain effective reclaimer operation.

(3) Establish and maintain effective filter operation.

(4) Maintain equipment to prevent mechanical losses.

(5) Operate the amine contactor with gas outlet temperature slightly higher than inlet temperature. This will prevent condensation of hydrocarbons in the contactor. Condensed hydrocarbons are believed to cause foaming and solution carryover. In some cases, foaming has been experienced even while this precaution was being observed. In these cases, it has been necessary to resort to a foam inhibitor such as octyl phenoxy ethanol.

In formulating the above suggestions, the authors have had the benefit of the thoughts of a number of individuals in Stanolind Oil and Gas Company who are connected with the design and operation of amine units. The authors wish to express their appreciation to the management of Stanolind Oil and Gas Company for permission to prepare and present this paper at the NGAA annual meeting, Dallas, April 22.

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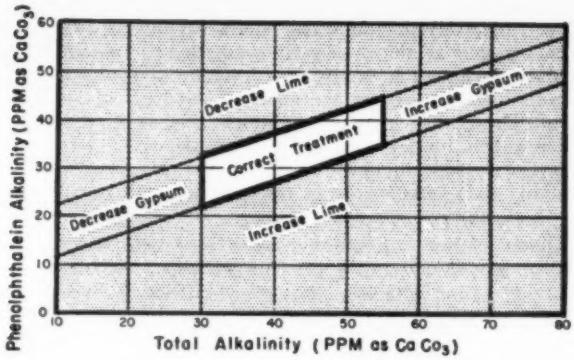

Figure 1. Lime-gypsum control chart.

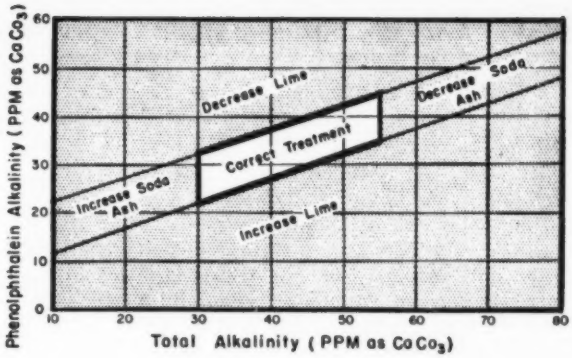

Figure 2. Lime-soda control chart.

Handbook to . . .

Water Problems and Their Solutions

Part II. Water Analysis Interpretation.

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THE SOLUTION of water problems usually is dependent on the proper interpretation of water analyses. Here are some interpretations of the more common water analyses that are used in the control of industrial systems.

Carbon Dioxide—Carbon dioxide occurs in most natural waters and in most treated waters. Concentrations over 10-15 ppm rarely are found in natural waters because the carbon dioxide would be lost by evolution as a gas or would be neutralized by alkaline material.

However, it is not at all unusual to find steam condensates with carbon dioxide concentrations of 20-50 ppm which makes them very corrosive especially if they are hot or under pressure. The carbon dioxide is removed from acid treated waters by aeration. A good aerator will remove the carbon dioxide down to 10-30 ppm and sometimes even slightly lower. In controlling a decarbonator, lowering the water rate, raising the air rate, or increasing the temperature should cause a decrease in the residual carbon dioxide content of the water effluent from the decarbonator.

Carbon dioxide in steam condensate can be controlled (1) by preventing the carbon dioxide from coming overhead with the steam by eliminating the carbonate salts which are its source, or (2) it can be neutralized by caustic, certain stabilized ammonia compounds, cyclohexylamine, morpholine, or octadecylamine. In some cases, it has proved practical to introduce boiler blowdown into the steam condensate return system for the neutralization of the carbon dioxide in the condensate. No matter which of these agents is used to control corrosion in the condensate system for neutralizing the carbon dioxide, it is usually satisfactory to add a sufficient quantity of the alkaline materials to maintain the pH of the return condensate at 7.0-8.5.

Hydrogen Sulfide—Hydrogen sulfide concentrations in water at atmospheric temperature and pressure rarely rises over 50 ppm and most water supplies contain much less than this. After treatment by aeration, and pH adjustment where necessary, the hydrogen sulfide content should not be over 1 ppm.

Hydrogen sulfide is a strong reducing agent and it forms insoluble salts of many of the heavy metal cations. Hydrogen sulfide is very corrosive and the corrosion product, iron sulfide, is quite troublesome in water systems.

Water containing hydrogen sulfide is usually treated by adding acid for pH adjustment where required, and passing the water over an open aerator tower which may be either forced draft or natural draft. The residual hydrogen sulfide content of the water effluent from the tower may be decreased by decreasing the water flow rate over the tower, by increasing the temperature of the water, by lowering its pH or by increasing the air rate to the aerator.

Ammonia—Concentration of ammonia in natural waters rarely rises above 30-40 ppm and usually is much lower than this. Where ammonia is left in treated waters, it can cause severe damage by attacking copper-containing alloys either in the form of direct corrosion or by serving

as an agent causing corrosion cracking. Ammonia corrosion does not often occur at concentrations less than 1 or 2 ppm, but corrosion cracking has been noted in the presence of waters containing only a fraction of a part per million of ammonia. General corrosion attack or dezincification type of attack can occur in almost any copper-containing alloy in the presence of sufficient quantities of ammonia. The corrosion cracking, is noticeable, ordinarily, only in those forms of brass which approximate the composition of unstabilized admiralty metal.

Where small quantities of ammonia are to be removed from a water system, it can best be accomplished by break-point chlorination or by cation exchange, usually in the hydrogen cycle. Where large quantities of ammonia must be eliminated from a water system, it can be most economically removed by making the water sufficiently alkaline followed by aeration, or heating.

Where chlorination is practiced, sufficient chlorine should be added to go beyond the so-called "breakpoint" that is marked by the second inflection in the curve formed by plotting the chlorine dosage as the abscissa and the chlorine residual as the ordinate. When removing ammonia by aeration, the ammonia concentration in the water leaving the aerator will be decreased by increasing the pH, lowering the water rate, increasing the temperature, or increasing the air to the system.

Dissolved Oxygen—Dissolved oxygen must be differentiated from chemically-combined oxygen present in water and many other compounds, but which are not available because of their chemical combination. Whereas well waters contain little oxygen, surface waters in equilibrium with the atmosphere usually contain from 6-12 ppm of dissolved oxygen. Where large quantities of oxygen are to be removed, stripping with an inert gas or the use of a vacuum deaerator are economical. For small quantities, chemical methods involving reaction with reducing agents may be considered.

Oxygen is the prime factor in controlling the corrosion rate of ferrous metals in the average water systems. Ordinarily, it is not economically feasible to control corrosion in open water systems by the removal of oxygen because of the constant reaeration that takes place in the cooling tower, but boiler systems that may be kept free of air are protected from corrosion as a standard practice by the removal of oxygen in heated deaerators.

Under ideal conditions for corrosion control, a closed system should be absolutely free of oxygen; however, for practical purposes, it is usually satisfactory to maintain a residual below about 0.25 ppm. In certain high-pressure boilers, however, where corrosion is a critical factor, it is normal to require the reduction of oxygen residuals below 0.01 ppm. The oxygen concentration in the effluent from a deaerator can be reduced by increasing the vacuum on the deaerator down to the vapor pressure of water at the temperature of operation or by increasing the temperature of the deaerator. If stripping gas is being used, increase of the gas rates within the designed limit of the equipment will usually result in a decrease in effluent oxygen concentration.

Chlorine—Chlorine is introduced into industrial and domestic water systems for the formation of hypochlorites to control micro-organisms.

Chlorine can be a factor in increasing the corrosion of the system to which it is introduced. It has three properties which lead to this fact. First, the introduction of chlorine in the water increases its oxidation potential and gives the effect of adding an equivalent quantity of nascent oxygen to the system. Second, the combination of chlorine with water causes the formation of a very strong acid which will reduce the alkalinity and pH of the system. Third, the chloride ion which is a small diameter monovalent ion, is itself a causitive factor in corrosion since it is able to penetrate protective films much more readily than some of the larger diameter multivalent ions such as sulfate and carbonate.

Some of these undesirable side effects may be reduced by combining the chlorine with ammonia to form the chloramines which are lower in oxidizing capacity and less corrosive from the viewpoint of acidification of the water, but still maintain a fairly high degree of toxicity. The formation of certain unstable organic chlorine compounds will also achieve this same effect.

Alkalinity—The alkalinity of a water sample is defined as the concentrations of constituents that will neutralize acid under certain narrowly specified conditions. The alkalinity of the water is essentially the capacity factor of its acid requirements as contrasted to the pH factor of water which is in effect the intensity factor of alkaline or acid materials in the water. In naturally occurring waters, both surface and underground, the largest contributing factor to the acid consuming power of water are the salts of carbonic acid. In natural waters, under certain conditions, or in waters that have been altered chemically, the acid consuming power of the water may also be raised by amines or other nitrogen basis, by the presence of salts of phosphoric acid, by acetates, chromates, or other salts and weak acids.

It is usual to consider that the alkalinity of the water is contributed only by hydroxyl ions, carbonate ions, and bicarbonate ions, and that only two of these ions can exist in significant quantities simultaneously. Since hydroxyl ions and bicarbonate ions react together to form carbonate ions, it is assumed that only hydroxyl and carbonate ions may exist simultaneously, or that carbonate and bicarbonate ions may exist simultaneously, or that any one of these may exist alone in the water. From theoretical considerations, it is known that all three forms of alkalinity may be co-existent in the system, but in practice, the concentration of the smallest one is ignored. In order to define the quantities of these compounds present, the alkalinity is measured at two pH levels. The acid consuming power of the hydroxyl ions and one-half of the carbonate ions is measured by adding acid until the pH drops to 8.3 which is the endpoint of the phenolphthalein indicator. Further addition of acid to reduce the pH down to 4.5 (the endpoint of the methyl orange indicator) will measure the remaining half of the carbonate ion concentration, and all the bicarbonate ions present in the water. By referring to Table I, it is possible to determine which ion or ions are present, and their relative concentrations. Since this analytical determination measures a group of ions, it is not possible to report them in parts per million of the ion measured as alkalinity. Therefore, the amount of acid required is reported in terms of normality, equivalents per million, or parts per million as calcium carbonate. In most water analyses, the alkalinity is reported as parts per million as calcium carbonate.

The alkalinity of natural waters may vary quite widely, but rarely does it fall below 25 ppm or rise above 500 ppm except in the case of brackish waters.

The presence of these forms of alkalinity in the water contributes to the formation of scale on heat transfer equipment. This alkalinity is a source of carbon dioxide which makes steam condensate corrosive, it promotes

boiler foaming, and is a source of hydroxyl ions which causes boiler metal embrittlement.

The alkalinity of water may be controlled by addition of acids, followed by deaeration to remove the released CO_2; by treatment with ion exchange resins; and by reaction with lime. Alkalinity control by acid is usually accomplished by adding sufficient sulfuric acid to the water to provide the desirable alkalinity at the effluent of the decarbonator. Alkalinity control by hydrogen cycle cation exchange usually involves the complete removal of the carbonates and bicarbonates, and if a controlled alkalinity is desired, it is achieved by blending the zeolite treated water with raw water. The alkalinity of the water may be reduced as low as 40-50 ppm (as $CaCO_3$) by treatment with lime (and some other soluble calcium salts where required). In this process, the bicarbonate ion is neutralized by the hydroxyl ion of the lime to form the normal carbonate ion. This carbonate reacts with the calcium of the lime to form the relatively insoluble calcium carbonate. Where the alkalinity of the water only slightly exceeds the hardness of the water, lime alone may be used successfully for maximum alkalinity reduction. In those cases where the alkalinity is considerably higher than the hardness of the water, additional calcium ions may have to be added in the form of a soluble calcium salt, usually gypsum or calcium chloride.

In order to provide assurance that all of the bicarbonates is converted to the carbonates, lime should be added until an excess hydroxyl ion of 5-15 ppm as $CaCO_3$ is present. This is indicated when twice the phenolphthalein alkalinity is 5-15 ppm higher than the methyl orange alkalinity. When the total alkalinity gets too high, it is an indication that additional gypsum is required, and when the phenolphthalein alkalinity exceeds one-half the methyl orange alkalinity by 5-10 ppm, it is an indication that too much lime has been used. Figure 1, shows the method by which the lime-gypsum treater is controlled using the total alkalinity and phenolphthalein alkalinity. For those waters whose hardness exceeds the alkalinity, softening is accomplished by using lime and soda ash. This process is also controlled by the relationhip of the total and phenolphthalein alkalinities as shown in Figure 2. The solubility of calcium carbonate limits the extent to which the hardness and alkalinity can be reduced by this method.

The alkalinity of the water in modern boiler is a critical factor, since alkalinities below 200 ppm indicate that corrosive conditions may exist in the boiler at high temperatures, and alkalinities in excess of 1000 ppm give warning that damage to the boiler metal by caustic embrittlement may occur. When water containing carbonates or bicarbonates is heated in a high-pressure boiler, some decomposition takes place and carbon dioxide is eliminated from the boiler with the steam leaving behind free hydroxyl ions. Hydroxyl ions can react with the boiler metal to generate nascent hydrogen which causes the metal to become very brittle so that it is no longer safe as a structural material for boiler construction. Since it is the hydroxyl ion that is the source of the embrittlement, many boiler operators prefer to set limits on the phenolphthalein alkalinities for this measure of alkalinity reflects the hydroxyl ion concentration and one-half of the carbonate concentration. Under constant operating conditions, however, there is usually a fairly definite relationship between the phenolphthalein and the total alkalinity determinations and since the total alkalinity measures the total ability of the water to form hydroxyl ions, other boiler operators prefer to control the total boiler alkalinity rather than the phenolphthalein alkalinity. Either method when properly interpreted is quite satisfactory.

TABLE 1
Alkalinity Calculations

	HCO_3	CO_3	OH
P=0	M	0	0
M>2P	M-2P	2P	0
M=2P	0	M	0
M<2P	0	2(M-P)	2P-M
M=P	0	0	M

P = Phenolphthalein Alkalinity (ppm as $CaCO_3$)
M = Total Alkalinity (ppm as $CaCO_3$)

Acidity—Since the pH of 4.5 has been arbitrarily set as the reference point for alkalinity, it is obvious that waters more acid than this will not only have no alkalinity, but would have a negative alkalinity. This negative alkalinity, or acidity, is the result of the presence of free mineral acids, or of acid salts such as sodium dihydrogen phosphate, sodium dichromate or sodium acid sulfate.

Free mineral acidity can be removed by neutralizing the water with caustic or soda ash, or in some cases, a form of natural calcium carbonate may be used such as lime stone or shell. Where the acidity is being controlled in this manner, the composition of the effluent will be governed by the rate in which the water is passed over the calcium carbonate. When the water rate is slowed down sufficiently, all of the free mineral acids will be removed.

Chlorides—The chloride ion is very important in water analysis since it does not undergo a change in most water treating reactions and it is easy to determine with great precision by using simple equipment.Chlorides are lost from a water system usually only by removal in an anion exchange unit, chlorides are added to water systems only through the use of chlorine or hydrochloric acid. Therefore, when these operations are not being carried out, a drop in chloride concentrations will indicate dilution and an increase in chlorine concentration indicates concentration by evaporation.

The chloride content of natural waters varies widely from less than 10 ppm to several thousand ppm. The exact value of the chloride concentration is less important than its changes throughout a system indicating dilution or concentration of the stream.

The chloride concentration ratio (the chloride concentration in the system *to* the chloride concentration in the makeup) is an important variable used in the control of industrial cooling equipment and boilers. This control cannot be used readily when hydrochloric acid is used for alkalinity control or in those cases where the makeup chloride concentration is low and chlorine is being used in the system for microbiological control.

The corrosion rates in industrial water systems usually depend at least in part, on the concentration of salts present in the water contained in the system. This is true since one of the limiting factors in the operation of the electrolytic cell causing the corrosion is the internal resistance of the cell. This internal resistance gets lower as the total dissolved solids content of the electrolyte in the cell goes up. Since it is difficult to run total dissolved solids determinations readily, a fixed ratio is determined for the chlorides to solids which will then allow a rapid estimation of the total dissolved solids from the chloride value which can be easily determined. When the chloride concentration gets too high, it may be reduced by blowing down additional water to waste from the systems and conversely when the chloride concentration falls too low, all sources of wastage of water from the system should be reduced to a minimum until the concentration rises back to the desired range.

Part III will conclude this series with an interpretation of the remaining ions in water analysis.

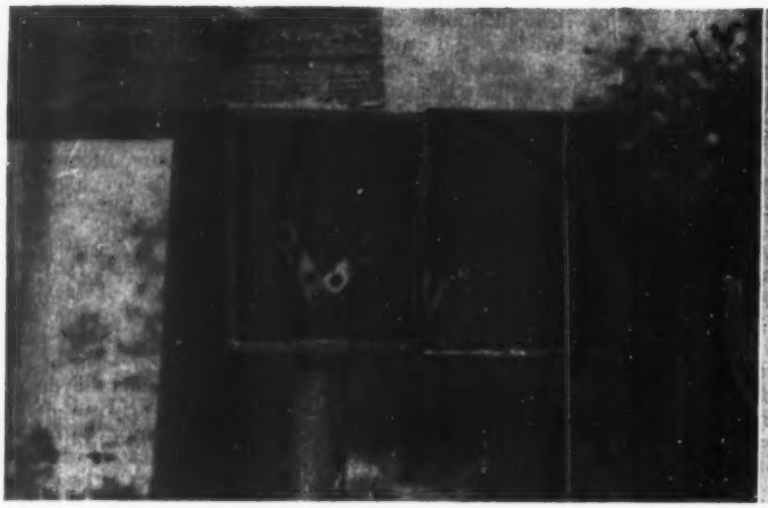

Figure 1. Resistance bonds installed in steel cabinet. Shunts included in circuit to allow checking current without opening bond.

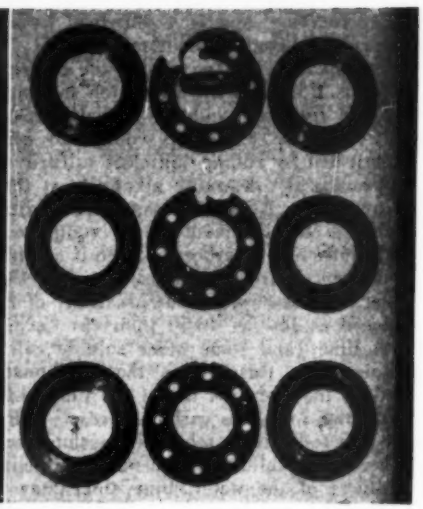

Figure 2. Damaged surge gaps removed from insulating flanges adjacent to power line.

Use these new techniques in . . .

Avoiding Underground Corrosion

These methods can increase the value of your present corrosion-mitigation efforts and can help you design corrosion out in future installations.

O. C. Mudd,
Shell Pipe Line Corporation,
Houston

THE PRESENT TREND of using relatively thin wall pipe, particularly in lines of large diameter, increases the importance of corrosion control to protect these important investments and reduce liability of future damages, loss of revenue and possible replacement costs.

Cathodic protection is generally recognized as an effective component in a balanced program of underground pipe line conservation; however, the increasing adoption and extension of this method of corrosion control on pipe lines and other underground structures increases the complexity of existing problems.

Anodic Metal for Electrical Grounds—Recognized safety regulations or applicable codes require one or more electrical ground beds with connections to all electrical equipment and associated metallic structures.

These ground beds generally are constructed by driving a number of copper clad steel ground rods in to the soil. Interconnections between rods and equipment are usually made with stranded copper of No. 4 B&S gage or larger.

This bare copper in the soil when interconnected through machines or piping to any buried iron or galvanized material establishes a continuous operating electrical battery or, more specifically a "galvanic cell." In such a cell the copper surface is the cathode which suffers little or no corrosion while the iron or zinc as anode surfaces are consumed in sustaining current flow.

Substitution of zinc rods or other metals of equivalent characteristics in lieu of copper clad rods will reverse the galvanic cell action with respect to bare iron and be at or near electrical equality with galvanized material. Benefits from this reversal can be improved if the exposed copper surfaces of the interconnecting conductors are avoided by installing conductors with moderate insulation, such as vinyl plastic.

This substitution of zinc for copper as grounding rods and the addition of insulation to interconnecting ground conductors has additional advantages where cathodic protection by impressed current is involved.

Impressed current flow from soil to zinc normally starts about 0.3 volt above the potential required to cause flow from soil to iron thus allowing establishment of satisfactory protection on iron surfaces before starting flow to the zinc surface.

Current normally flows from soil to copper surfaces before flowing to iron and the potential between soil and copper surfaces normally must exceed 0.55 volt before starting current flow to iron surfaces in the vicinity. By the time satisfactory protection is established on iron surfaces, the potential between soil and copper in the proximity will usually exceed 0.85 volt thus increasing the unneeded current flow to the copper. Current densities exceeding two milliamperes per square foot of copper surface have been observed where iron pipe in the proximity was under protection. Thus eliminating copper grounding rods and

insulating interconnecting copper grounding cables prevents undesired current flow to those surfaces.

Each 5/8-inch ground rod 8 feet long has more than one square foot of area and 13.5 feet of No. 4 or 11.75 feet of No. 2 stranded conductor has one square foot of soil contact area. A proposed layout of zinc rod ground bed is illustrated in Figure 3, and some of the installation features are illustrated in Figure 4.

Galvanizing to Conserve Protective Current—Galvanizing steel results in an exposed surface of zinc, hence it may be more practical to galvanize some steel structural materials in preference to coating, such as small diameter pipe. Any abraisions or damage of the galvanizing such as threads or tool marks should be coated before burial.

Another avenue of needless protective current flow is from soil through concrete to reinforcing steel in foundations when this steel has incidental or intentional contact with underground structures under cathodic protection.

The current density to reinforcing steel surfaces seldom exceeds 0.5 milliampere per square foot but the total area of exposed steel in a recently designed 1500-hp motor-pump foundation amounted to 280 square feet.

Current flow via this avenue has been controlled successfully by avoiding contact between anchor bolts and reinforcing steel and by placing an insulating tube around the anchor bolt before pouring concrete. A typical illustration of such construction is shown in Figure 5.

Tests have demonstrated that galvanizing reinforcing steel restricts current flow until the protective potential of bare steel approaches that necessary for the start of current flow to zinc surfaces. Thus galvanized steel plates embedded in the surface of concrete will limit current flow to metal equipment or structure supported on the plate surface such as gate valves, strainer bodies, or similar equipment. Heavy galvanizing appears to be more effective in concrete.

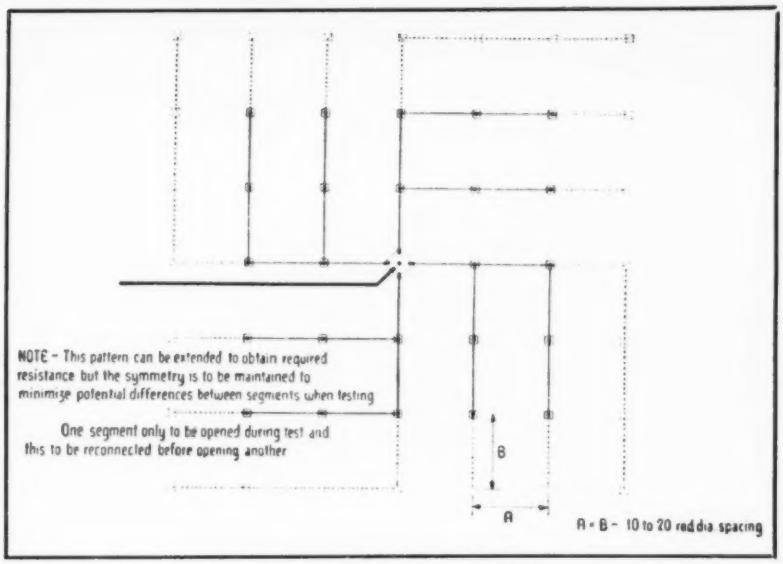
NOTE – This pattern can be extended to obtain required resistance but the symmetry is to be maintained to minimize potential differences between segments when testing
One segment only to be opened during test and this to be reconnected before opening another
B
A
A = B – 10 to 20 rod dia spacing

Figure 3. Layout plan of ground bed.

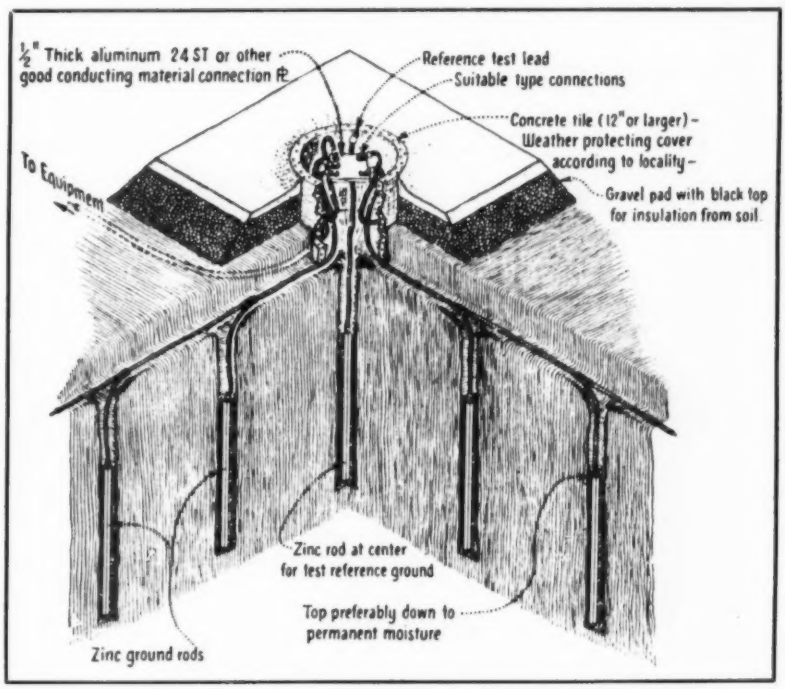
½" Thick aluminum 24 ST or other good conducting material connection fr
Reference test lead
Suitable type connections
Concrete tile (12" or larger) – Weather protecting cover according to locality –
Gravel pad with black top for insulation from soil
To Equipmem
Zinc rod at center for test reference ground
Top preferably down to permanent moisture
Zinc ground rods

Figure 4. Cutaway view of anode installation and connections.

Electrical Current Drainage Bonds—Electrical current drainage bonds between underground structures are installed primarily:

(1) To establish equality of protection between adjacent structures.
(2) For alleviating damage to nearby unprotected structures.

Bonds installed for the purpose described in item one are usually of low resistance and these need no consideration except for safety precautions when opened.

Bonds described under item two are adjusted for resistance to restrict the amount of current flow. Frequently these are installed with resistance wire of low current conductance capacity.

The results from installations using low conductance wire can be illustrated from experience. Resistance bonds were installed at 23 pipe line crossings in North Texas during 1937 using No. 18 Nichrome wire. Inspections of these bonds during 1939 revealed only five remaining. Those missing were apparently vaporized by lightning current surges.

Bonds installed with No. 12 Nichrome wire have remained intact for more than eight years. It is preferable when possible to install such bonds in suitable boxes above ground as illustrated in Figure 1 to allow quick inspection and adjustment when required.

Recent experiences demonstrate the need of unidirectional electrical de-

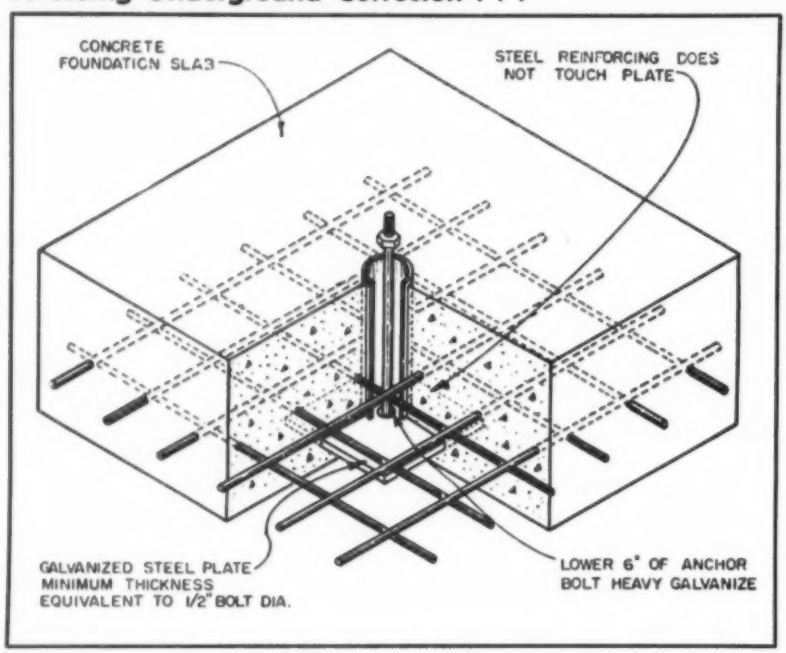
CONCRETE FOUNDATION SLAB
STEEL REINFORCING DOES NOT TOUCH PLATE
GALVANIZED STEEL PLATE MINIMUM THICKNESS EQUIVALENT TO 1/2" BOLT DIA.
LOWER 6" OF ANCHOR BOLT HEAVY GALVANIZE

Figure 5. Galvanized plate and bottom six inches of anchor bolt and sleeve to protect engine and connect underground piping.

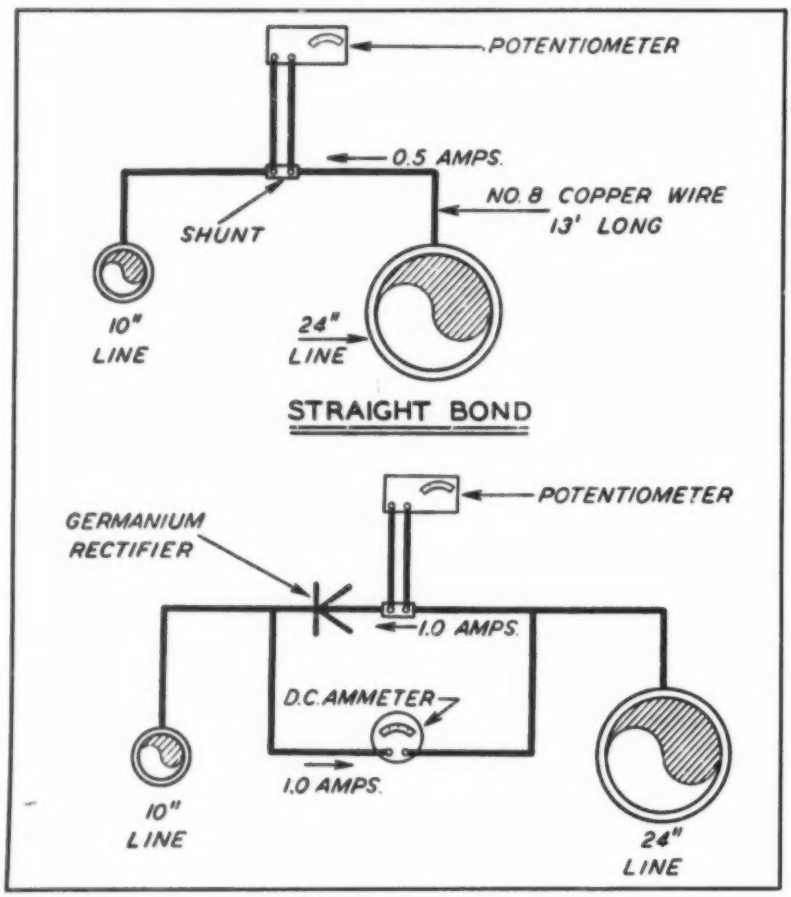

Figure 6. Bond with rectifier.

vices in bonds between different structures to control current flow direction, particularly where each structure involves one or more sources of protective current. Tests at one bond indicated 0.5 ampere flowing in the desired direction from one structure to another. A germanium rectifier element was inserted in the bond to prevent reverse current flow in case of failure at the impressed current source on the draining line. After inserting this rectifier element current flow measured 1.0 amperes in the desired direction and an ammeter bridged around this element simultaneously indicated 1.0 ampere flow in the opposite direction, hence new complex problems face the corrosion engineer and new techniques are essential in determining real values under such conditions. Diagrams of this bond connection are illustrated in Figure 6 showing current magnitude and direction. All involved rectifier units were served by the same utility system.

Safety precautions are important when working with bonds between lines and this is evident from the previous history of destroyed bonds. No work by personnel should be done on or near bonds when any visible electrical storms are in progress! Opening a bond under normal conditions may even cause a spark capable of igniting combustible vapors. Pouring water over the contact during opening will minimize ignition hazards and provisions for opening contacts submerged in water or nonflammable liquid will eliminate spark hazards.

Surge Arresters on Flanges—Electrical surges from lightning or other electrical sources causing damage to drainage bonds have likewise caused damage to insulating flanges and provisions are necessary to bypass these surges without damaging flange insulation.

Records thus far indicate that flange insulation is seldom damaged where the soil resistivity is less than 3000 ohms cm^3 and the severity of damage increases with increasing soil resistivity.

High potential power transmission lines paralleling pipe lines especially in high resistance soils have caused unusual damage to flange insulation and surge gaps. Figure 2 is a photograph of damage surge gaps removed from insulating flanges near a high potential power line. Such exposures will require other types of arresters that can accommodate higher surge currents.

Safety precautions for personnel around insulating flanges during electrical storms are equivalent to those to be observed with electrical bonds—avoid body contact.

Casebook of a Corrosion Chemist

Part II continues the series of reports of unusual corrosion problems and their solutions.

Maxey Brooke, Phillips Petroleum Company, Sweeny, Texas

6. The Case of the Hose That Sparked

Problem: When dockmen were making up a cargo hose to a tanker or barge, they noticed sparks forming as the flanges were brought together. This was dangerous and immediate corrective action was necessary.

Investigation showed that the sparks were the result of cathodic currents, emanating from the cathodic protection system on the pipeline, and subsequently picked up by the bottom of the vessels. These currents were attempting to flow back to the rectifier whence they came.

Remedy: A flexible grounding cable was attached to the pipeline near the point where the hose joined. The cable passed through an explosion-proof switch and terminated in a special C clamp with pointed jaws. Before the hose is made up, the clamp is attached to the deck of the vessel firmly enough to give a good electrical contact. The explosion-proof switch is closed and the hose is made up. No sparks have been observed since this system was put in service.

7. The Case of the Bad Blowdown Line

Problem: The 10-inch blowdown line from a hot process lime-soda water softener led to a blowdown pit about 50 feet away. The line was buried about a foot below ground. Approximately every eight months a hole would appear about midway between the softener and the blowdown pit.

One end of the pipe was in contact with the sludge in the blowdown pit which had a pH of 10.5-11.0. The soil surrounding the pipe had a pH of 6.5-7.0. The corroded area was bright and shining. These conditions indicated concentration-cell corrosion.

Remedy: The terminal of a 15-pound magnesium anode was welded to the pipe at the corroded area and the anode buried nearby. After four years service, no further active corrosion was observed.

8. The Case of the Corroded Conduit

Problem: Steel conduit carrying cables to the fan motors of an induced draft cooling tower were failing rapidly. The portion of conduit along the top of the tower was noticeably thin after six months. In 18 months corrosion had advanced to the point that the conduit had to be replaced. The atmosphere around the conduits was saturated with water vapor and small droplets of water. The cooling water was chlorinated continuously and the atmosphere contained enough chlorine to be easily distinguished by odor. Variations in temperature from day to night caused chlorine-containing water vapor to condense on the conduit. The failure was a combination of acid and oxygen corrosion.

Remedy: At the time the conduit was installed, experimental sections of aluminum conduit were included. After 18 months, there was no measurable metal loss in these sections. The conduit system was therefore replaced with aluminum.

9. The Case of the Hole in the Pump Impeller

Problem: A reconditioned impeller was installed in a low head pump at a co ling tower. After about one year's service, several large holes were eaten through the impeller. Investigation showed that the impeller was cast iron. During reconditioning, parts had been built up by means of stainless steel spray. The cast iron immediately adjacent to the stainless steel was severely corroded. The holes, be it noted, were a result of galvanic corrosion.

Remedy: The impeller was replaced with one made of bronze. No further attack has occurred after four years use.

10. The Case of the Rusty Radiators

Problem: A film of rust appeared in the cooling sections of the laboratory antiknock engines. Although it was not thick enough to interfere with the water flow, it was felt that any change in heat transfer coefficient might interfere with obtaining accurate results. Sight glasses became stained and made it difficult to check water levels. This condition was the result of oxygen attack on the metal walls.

Remedy: Potassium chromate was added to the radiator water to give a concentration of 300-500 ppm chromate. Sodium hydroxide was added to give a pH of 8.5-9.0. This treatment not only prevented further formation of rust, but the old rust stains disappeared in about six weeks.

11. The Case of the Clogged Chlorinator

Problem: The hose carrying concentrated chlorine solution from a chlorinator to a domestic water line stopped up with a gelatinous material after about six months operation. The water being furnished the chlorinator was cold lime-soda softened water taken from a concrete storage basin. Analysis of the deposits indicated that it was calcium silicate. Presumably there was some slight attack on the walls of the storage basin. When this material came in contact with the strongly acid water in the chlorine discharge hose it was precipitated.

Remedy: Ion exchange softened water was substituted for the lime-soda softened water. No further clogging has occurred in four years operation.

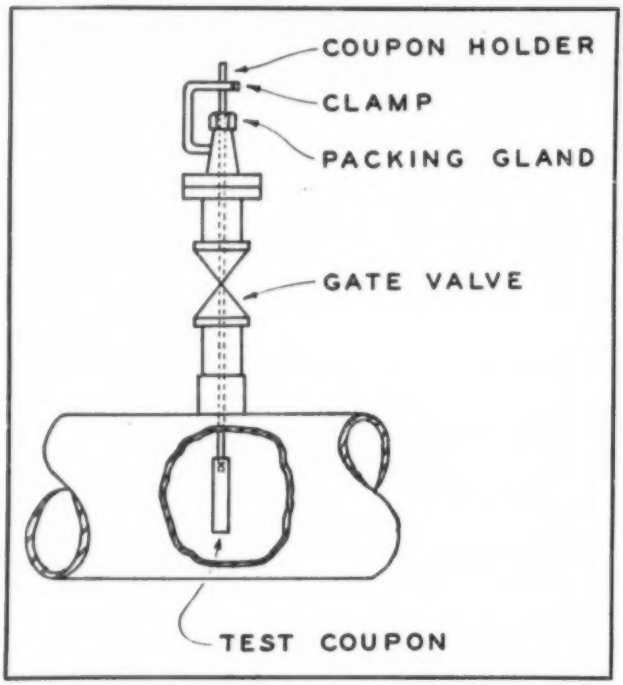

Figure 1. Coupon installation in flow line through packing gland.

Here is a review of . . .

Corrosion Investigating

These field and laboratory methods can help you

- **Locate pitting and weak spots**
- **Measure corrosion rates**
- **Pinpoint your corrosion problem**
- **Evaluate inhibitors**

DURING World War II, shortages of steel products and alloys started the oil industry on an intensive study of its corrosion problems. Prior to that time, oil field corrosion received only scattered attention in research laboratories, with emphasis placed on corrective measures, particularly on corrosion resistant materials of construction. During the war, corrosion resistant alloys were unavailable. Oil producing companies encountering the high cost of tubing and rod replacements in oil wells, organized corrosion committees and initiated research programs in an effort to learn more about these problems and to find methods of minimizing the corrosion.

We, in gasoline plant operations, have been somewhat slow in maintaining our share of the progress—partly because our problems were not as costly, and partly because we had employed corrosion resistant materials of construction to limit our corrosion problems. We have also built high factors of safety into our lines and vessels which gave them longer life and made the corrosion problem appear less severe than it was in actuality. It has been only recently that the operators have begun to find out just how much the problem of corrosion is costing in gasoline plants. We have always had the problem. We have lived with it. We have failed, in most cases, to keep sufficient records to tell us the whole sad story.

This is a discussion of the tools, that is, the field and laboratory techniques that can be used by the engineer in making an investigation of potential corrosion problems and in evaluating the merits of inhibitors or other corrective measures.

The engineer has four questions to answer;

How severe is the corrosion problem, both from the economic point of view and from the safety point of view?

What is the basic cause of the corrosion?

What can be done to combat it?

How effective and how costly is the treatment?

The answer to these questions can be obtained by making corrosivity and inhibitor evaluations.

Corrosivity Evaluation—Evaluation of the corrosivity of a system is made on the basis of past history and plant maintenance records, visual and instrument inspections, corrosion rates established by test coupons and iron counts, and by various other chemical tests to indicate the presence of known corrosive gases. The history includes a record of failures and replacements, and an economic analysis should be made from the cost of these replacements. Records of safety hazards and personnel injuries should also be made. Classification of the severity of corrosion, from the economic and safety standpoints, can be made on the basis of these records.

The engineer, however, finds that in many cases there are almost no records—only those which the plant and maintenance foremen carry in their heads, and records based on memory are not reliable. In such cases, the history and maintenance data must be started from scratch and records kept as the investigation continues. In any problem, the only positive means of evaluating corrosion and inhibitor effectiveness is to maintain a complete story on the system.

Visual and Instrument Inspections—In locations where corrosion is known to occur and particularly where a safety hazard may be involved, periodic inspection of the piping and equipment should be scheduled. This can be done during shutdowns, when making equipment replacements; or while operating, by use of thickness-indicating instruments. Plant and maintenance repair men should be told what information is desired, and they should report on all systems where they find corrosion occurring. It is helpful to provide these crews with corroded specimens of different classes so that they will have something for comparison. These can be arranged in panel form with each specimen plainly labeled for "Light Rust," "Medium Rust" and "Heavy Rust" and also the several types of pitting: "No Pitting,"

Techniques

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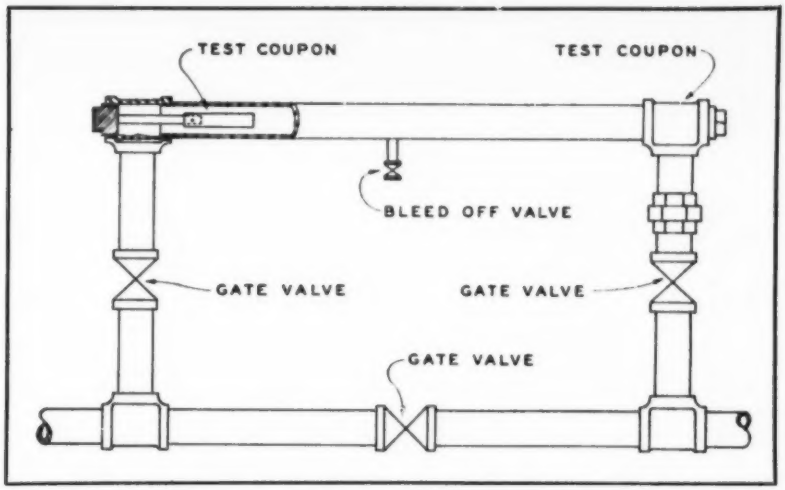

Figure 2. Bypass arrangement for coupon installation in a liquid flow line.

"Isolated Shallow Pits," "Frequent Shallow Pits," "Isolated Deep Pits" and "Frequent Deep Pits or Pits Not Measurable. No Original Pipe Surface Left." Such a panel is used by the maintenance crews of one company so that they can give a relatively accurate report on what is found. The corrosion engineer can then keep abreast of the problems by reviewing these reports.

Thickness-Indicating Instruments—Where the corrosion causes a possible hazard and periodic inspection is required between shutdowns, thickness-indicating instruments are used to follow the rate of corrosion. There are three general types of instruments for making wall thickness determinations of lines or vessels:

(1) Gamma ray instrument.
(2) Resonance type ultrasonic instruments.
(3) Echo type ultrasonic instruments.

The gamma ray type of thickness detector employs the penetrating power of gamma radiation to measure metal thickness. Gamma rays from the source are directed through the material being measured into a counter. The source employed is approximately one milligram of a commercially available radium salt. The cource is surrounded with a shield containing a window which directs the beam of gamma rays in the desired direction. The intensity of radiation at the counter is reduced by absorption in the material being tested. The amount of this reduction depends on the density and thickness of the material. The counter and electronic circuit convert the resulting intensity of radiation into a direct current which is read on a microammeter. A thickness measurement is obtained by comparison of this reading with a calibration curve.

This instrument measures the average wall thickness of an area of from one to three square inches, depending on the size of pipe and type of head being used. The instrument gives an accurate determination of metal thickness when the surfaces are fairly uniform and where the corrosion has resulted in general thinning of the metal. Since the result is the average thickness of about one to three square inches, the instrument will not indicate isolated or infrequent pitting. The accuracy is also somewhat affected if the metal is backed by scale, corrosion product, or liquid, and for best results lines should be drained when measurements are being made. This type of instrument will not indicate laminations or flaws in the metal and consequently, can be used to measure total thickness of laminated or lined vessels.

There are several resonance-type ultrasonic thickness testing instruments available for the industry. These instruments measure thickness of materials by reflection of sound waves. In operation the instrument emits, through a quartz crystal, a high frequency sound wave which passes through the metal being measured and then reflects in sound waves from the back surface. When the transmitted and reflected sound waves are in phase, the thickness can be determined by a formula based on the speed of sound and the frequency in the particular medium which causes resonance.

These instruments determine an average thickness of the area under the crystal, which may vary in diameter from $\frac{3}{8}$ inch and larger. Accurate thickness measurement can be made on fairly uniform surfaces. The results will detect laminations in the material and are not affected by liquid or corrosion products backing the metal. The instrument will measure only the outer layer of metal in these cases. This type of thickness gauge is the least expensive of the thickness measuring devices discussed here and has been widely used in oil refineries.

The echo-type ultrasonic gage[1] has recently been experimentally used in the gas industry. Some development work is still being carried on, however, and the equipment is not yet available commercially.

This instrument determines the thickness of metal by measurement of the time taken for an ultrasonic wave to travel to the back surface of the material and return to the crystal. For this measurement the instrument employs higher ultrasonic frequencies and a special radar type circuit. The $\frac{1}{8}$-inch diameter crystal used will accurately indicate pitting, depth of pit, and any laminations in the vessel. Corrosion products or liquid behind the material do not affect measurements.

The continuation of development work on this type of instrument is being directed toward making rapid scanning of pipe or vessels possible. At the present time only that area of pipe under the crystal is measured with any of these instruments, and covering large surface areas, without prior knowledge as to where the corrosion might be occurring, is costly and time consuming. In the hands of an engineer, however, who knows their values and limitations, these instruments are a useful aid in investigation of many corrosion problems and in reducing the hazard to plant personnel where failures might occur if corrosion progresses too far.

These instruments can also be employed to establish corrosion rates be-

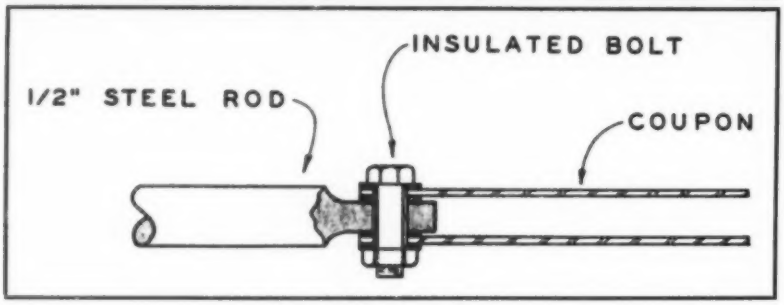

Figure 3. Test coupon holder.

fore and after treatment as a means of evaluating effectiveness.

Test Coupons—Measuring the corrosion rates of iron test coupons installed in a corrosive system, gives the engineer another valuable tool for use in a corrosion investigation and for evaluating effectiveness of inhibitors. Coupon corrosion rates are not an absolute measure of the rate at which piping and equipment is actually corroding; however, comparison of results with those of other systems or comparison of rates before and after treatment enables the engineer to evaluate the problem more thoroughly.

The use of coupons is limited. Installation of a coupon in a flowing stream may change the turbulence in the system and result in different corrosion rates at this point. Varying velocities and turbulence have considerable effect on corrosion rates. It is also not always possible to install the coupon in just the right location, and it is often hard to reproduce results.

Iron test strips, ½ x 3 inches or 1 x 3 inches, SAE 1020 hot rolled steel, are generally used for coupons. Test strips are easily handled an can be installed in a system through a packing gland arrangement without a shutdown. Rod coupons, test nipples, spools, or sleeve coupons may also be employed. Test nipples and sleeve coupons are better than strips but are often hard to install and remove. If they are installed in a regular flow line, the installation requires a shutdown. If they are placed in a bypass line, flow conditions may not be the same, and the corrosion rate may vary accordingly.

Test coupons may be prepared prior to weighting by (1) electrolytic cleaning (2) acid etching or (3) sand blasting plus degreasing with carbon tetrachloride. The simple sandblasting treatment has been found to give more reproducible weight losses than do the other methods which have been previously used. Some work has also been done expreminentally, blasting with fine aluminum oxide, and results indicate that this method may give even more reproducible results than blasting with fine sand.

After preparation, coupons are weighed and stored in a desiccator until installed in the system. Care should be taken during preparation and installation not to touch the coupon, since oil from the skin on the surface of the metal will affect its corrosion rate. Coupons should be installed in a system in a relatively non-turbulent zone. Turbulence causes channeling on coupon surfaces and gives greater weight losses than would result from corrosion alone.

Test specimens being placed in a system where the corrosion is due mainly to an acid effect, should be electrically insulated from the line and from each other in order to eliminate any possible galvanic effect created by installing the coupons. If the corrosion in the system is due to a galvanic effect where the anode and cathode are separated, it is best not to insulate so as to obtain the full effect of the corrosive action. In this case, however, when galvanic effects lead to pitting, the true severity of corrosion cannot be determined from weight loss of coupons.

Figures 1 and 2 show two methods of installation of coupons. Figure 1 shows installation of coupons through a packing gland into a gas flow line. Figure 2 shows an installation in a bypass liquid line. As many as four coupons can be installed at one time by this method, permitting removal of the test specimens at different intervals of time. Figure 3 shows the method of insulating coupons from the holder when installed.

Coupons are generally left in the system for two to four weeks. When they are removed at the conclusion of the test, they should be wiped with a cloth and placed in a bottle containing acetone or light oil. This prevents further corrosion by contact with air while they are being transported to the laboratory for cleaning and weighing. Exposed coupons are cleaned by scrubbing with kitchen cleanser, rinsed with water, and dried by dipping in acetone and blowing with air.

Coupon corrosion rates are calculated from the weight loss during the exposed period and are expressed as surface penetration in mils per year (1 Mil = .001-inch). Weight loss can also be complted as pounds of steel loss per 1000 feet of pipe to check data obtained by iron count.

In addition to checking corrosion rates and determining inhibitor effectiveness, coupons may be fabricated from different alloys to aid in evaluation of alloy materials in construction of vessels, coolers, and other equipment for corrosive service. The NACE in connection with the NGAA condensate well corrosion committee made surveys a few years ago, in which 32 alloy coupons were installed in spools in condensate well flow lines to obtain data on the corrosion resistance of different metals in this service.

Iron Counts — A measure of the iron content (iron count) in the condensed water in the system, presents another means of determining corrosion rates and evaluating the effectiveness of inhibitors. The amount of iron being carried out of a system is a direct measure of the rate at which the steel equipment is being corroded. Iron concentrations are determined in the laboratory by colorimetric test using either the thiocyanate or thioglycollic acid methods. Iron counts are reported as ppm of iron in the water sample. To get a true rate of corrosion, it is also necessary to get a measurement on the volume of condensed water and calculate the total weight of iron being removed from the system. This result can then be compared with determined coupon corrosion rates.

Iron counts are of much more value when determinations have been run periodically for several weeks rather than relying on a few isolated tests. Periodic tests also make it possible for the engineer to follow the changes of corrosion rate due to uncontrollable variables in the system.

Due to these uncontrollable variables in the system and difficulties in sampling, information obtained by iron count is not always reliable. Some of the difficulties which are encountered and which result in incorrect iron counts can be traced to the following:

(1) Non representative sampling
(2) Improper treatment of the samples in the field
(3) Loss of iron by solution in the hydrocarbon liquid phase or by suspension in an emulsion layer between the water and hydrocarbon phases.

(4) Reaction of ferrous iron with oxygen or other gases in the system which results in a precipitation of iron from the water prior to sampling.

The problem of obtaining a representative sample is important and not an easy one. However, the variables involved in sampling can be controlled if proper methods are followed. The engineer should supervise the sampling and insist on necessary precautions to obtain good samples since iron precipitates quite rapidly from solution after coming in contact with air and is not too readily redissolved, acid should be added to the sample bottle before sampling. This will keep the iron in solution until the analysis is run in the laboratory.

When the volume of hydrocarbon condensate is relatively large, or when an emulsion layer is encountered, checks should be made for iron content of these layers. If any is present, then this iron must also be determined and added to the iron content of the water phase. Some organic inhibitors tend to bring the iron into the hydrocarbon phase which increases this difficulty.

When oxygen or hydrogen sulfide is present in the system, precipitation of the iron from solution may occur before sampling. This cannot be controlled and should be taken into account when evaluating iron counts. When corrosion products are present as solids in suspension in the condensed water, the iron count should not be used as a means of evaluating corrosion.

Additional Data—There are a number of chemical analyses that are also employed by the corrosion engineer to aid in his investigations. These are all published in the literature, and details will not be given here.

Tests should be conducted to establish the condensed water composition and to check the carbon dioxide, free oxygen, and hydrogen sulfide content of the gas. Additional tests may be run to show the presence of mercaptan sulfur and organic acids. From these analyses pH of the condensed water under operating conditions can be estimated. When using inhibitors, a test to check inhibitor concentration is also advantageous.

When a relatively large volume of hydrocarbon liquid is being handled, it is also helpful to know the wetting properties of the hydrocarbon. This can be determined by the drop-size ratio test developed by the NGAA condensate well corrosion committee.

It has been assumed that the corrosion problem is an internal one caused by the acid gases in the natural gas systems. It may be that the corrosivity evaluation will indicate galvanic corrosion or corrosion due to stray currents; or that the problem is a metallurgical one, such as improper heat-treating, in which case additional tests will be conducted along these lines. These will not be discussed here because they are specific problems and not general.

Tests employed in connection with cathodic protection and protective coatings of buried lines, also, are not discussed since these measures are established and are effective.

Inhibitor Evaluation—There are a number of methods which are employed in laboratories to obtain quick evaluation of corrosion inhibitors. The main purposes of these tests are (1) to show which inhibitors are sufficiently effective to be tested in field operating systems, (2) to indicate the effect of concentration on inhibition, and (3) to determine the effectiveness of given inhibitors under a variety of conditions.

Discussion of all published methods would be too involved to be handled satisfactorily in a paper such as this. Many of these methods have advantages over the others. However, in order to show what can be done in the laboratory, three different methods will be discussed briefly.

In a paper presented at an annual meeting of the NACE Ryznar and Green[2] discuss the use of a rotary rod coupon to study corrosion and inhibition. A .25-inch diameter, 1020 mild steel coupon is rotated at constant speed in a corrosive water for 24 hours. During this time, potential measurements are made at suitable intervals, and at the completion of the test an iron count is run on the water. Results are evalulated on the basis of visual inspections, potential data, and iron counts. Results are easily reproducible. This method can be used to study the effect of variable velocities (by changing the speed of rotation), temperatures and corrosive medium, and to evaluate inhibitors.

Measurement of the surface potential of a coupon as a means of studying inhibitors has been done with a "Rotogenerative detector."[3]

This apparatus is essentially a detector of local action currents. A cylindrical coupon is rotated at a controlled speed in a corrosive solution. Opposite the coupon is a fine tipped electrode with a variable distance between the electrode and the coupon which may be as low as .001 inch.

As the coupon rotates under fixed conditions, the average potential of points on the surface adjacent to the electrode is measured by means of an electronic circuit. The effect of inhibitors on the rate of corrosion of the coupon can be determined by these measurements. The apparatus can be used to study effect of inhibitor concentrations and the presistency of the protective film.

Scott and Rohrback[4] have employed the measurement of hydrogen evolved during corrosion as a means of evaluating inhibitors. A cylindrical coupon is rotated in a flowing corrosive solution. The gas and liquid leaving the coupon are separated and the amount of hydrogen in the gas stream is determined by means of a thermal conductivity cell. This provides a means of continuously measuring the rate of hydrogen evolution and consequently, the corrosion rate. The effect of an inhibitor on this rate is studied by injecting it into the flow stream in front of the coupon and recording any change in the rate of hydrogen evolution. This method is advantageous because of the short time it takes to make a test. The method can be used to study (1) the rate of reduction of corrosion when inhibitor is added, (2) the effectiveness of different concentration of inhibitors, and (3) the persistency of the inhibitor protection when injection is stopped.

Inhibitors which show good protection by one or more of these laboratory tests are then tested in a corrosive plant operating system. Pumps, lubricators, or pressure feeders may be used to inject the inhibitor into the field system. Visual and instrument inspections, coupon corrosion rates, iron counts, and chemical tests for inhibitor concentration are employed to initially establish optimum treatment and to follow progress of the test over a period of months. Complete evaluation of the inhibitor effectiveness must be made on the basis of plant maintenance cost data before and after treatment and on the elimination of safety hazards.

Only by continued efforts on the part of the corrosion engineer and all plant maintenance and operating personnel can the corrosion control program be made effective. By the combined effort of these people we will finally be able to say, "we have reduced plant costs due to corrosion, and we have made the plant a safer place to work."

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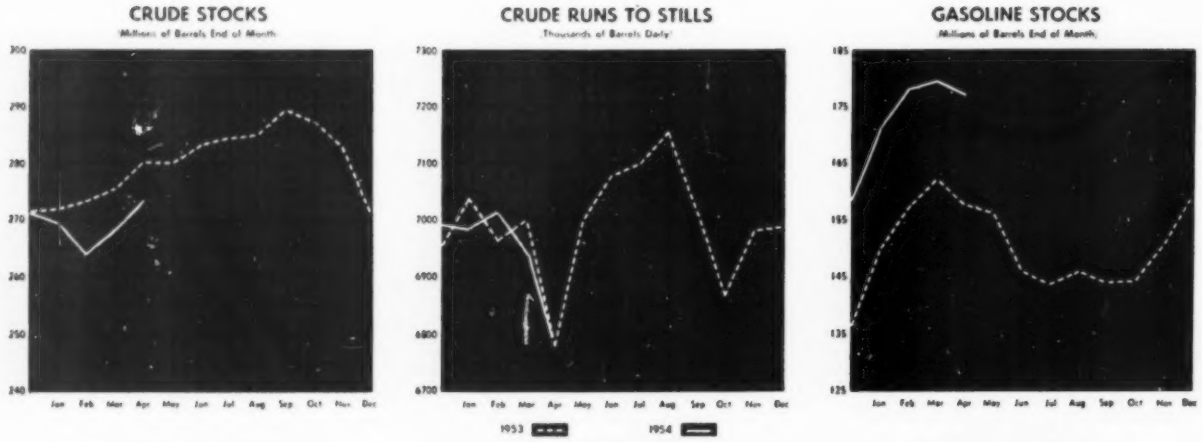
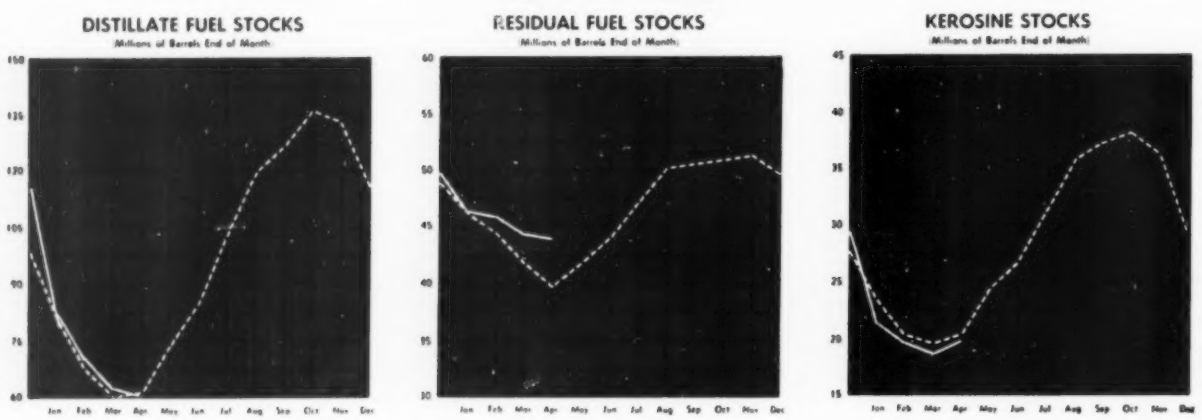
[2] Ryznar, J. W., and Green, J., "A Simple Test Method for Evaluating Corrosion Inhibitors," presented at annual meeting, NACE, St. Louis, April, 1948.

[3] Cyrus Rice, Jr., presented at the annual meeting, NACE, Chicago, March, 1953.

[4] Scott, Willard R., and Rohrback, Gilson H., "A Hydrogen Evolution Method for Evaluation of Corrosion Inhibitors for Oil Wells," Corrosion, July, 1952, p. 225-256.




DISTILLATE FUEL STOCKS
Millions of Barrels End of Month
RESIDUAL FUEL STOCKS
Millions of Barrels End of Month
KEROSINE STOCKS
Millions of Barrels End of Month

Taking Stock

Cecil W. Smith
Economics Editor

(DATA IN THOUSANDS OF BARRELS)

MONTH	CRUDE OIL			GASOLINE		KEROSINE		DISTILLATE FUEL		RESIDUAL FUEL		DAILY IMPORTS	
	Production Daily	Runs to Stills Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Crude Oil	Total Oils
1952:													
August	6,219	7,118	264,368	3,377	118,592	375	32,401	1,514	104,257	1,252	54,061	632	879
September	6,518	7,017	264,723	3,428	120,991	350	35,021	1,502	117,252	1,230	56,200	615	932
October	6,518	6,883	269,776	3,301	120,062	352	33,289	1,458	120,721	1,203	53,052	643	1,038
November	6,487	7,049	267,852	3,416	129,509	393	32,199	1,510	116,096	1,299	53,099	624	984
December	6,634	6,952	271,928	3,361	136,028	421	26,842	1,509	99,582	1,302	48,706	603	1,165
1953:													
January	6,555	7,042	272,250	3,384	150,518	433	23,292	1,528	80,655	1,307	45,910	616	1,135
February	6,562	6,969	273,589	3,379	157,873	404	20,468	1,505	67,167	1,275	44,178	586	1,066
March	6,531	7,002	275,665	3,319	162,731	359	18,697	1,489	59,802	1,256	41,600	655	1,112
April	6,446	6,781	280,487	3,282	158,032	361	20,335	1,424	61,349	1,219	39,572	628	1,010
May	6,390	7,002	280,308	3,366	156,415	327	24,307	1,400	73,705	1,197	41,795	703	1,098
June	6,595	7,081	283,715	3,467	146,196	326	27,659	1,462	84,504	1,238	43,801	707	1,050
July	6,603	7,103	284,976	3,583	143,916	321	31,143	1,441	102,258	1,224	47,530	629	950
August	6,583	7,163	285,352	3,592	146,050	321	35,711	1,437	119,542	1,222	50,007	672	946
September	6,557	7,023	289,614	3,521	144,184	330	37,280	1,448	128,709	1,203	50,516	692	1,013
October	6,262	6,872	287,541	3,437	144,495	355	38,161	1,462	135,409	1,184	50,820	639	990
November	6,277	6,987	283,021	3,528	150,747	354	36,271	1,463	133,381	1,223	51,267	648	1,120
December	6,238	6,964	276,676	3,628	159,949	378	29,070	1,441	111,944	1,247	49,370	598	1,121
1954:													
January	6,240	6,947	270,811	3,431	171,704	390	22,013	1,467	81,044	1,271	47,474	617	1,143
February	6,379	7,068	266,918	3,476	179,950	412	20,183	1,545	70,390	1,241	47,119	621	1,144
March	6,349	6,936	267,859	3,376	179,225	373	17,598	1,490	60,024	1,185	43,879	621	1,044
April	6,580	6,791	273,860	3,241	177,197	316	19,514	1,359	61,050	1,183	43,611	551	896
April, 1954 Change:													
In Month	+231	−145	+6,001	−135	−2,028	−57	+1,916	−131	+1,026	−2	−268	−70	−148
In Year	+134	+10	−6,627	−41	+19,165	−45	−821	−65	−299	−36	+4,039	−77	−114
Week Ended:													
5-22-54	6,435	6,969	275,000	3,336	174,552	290	22,263	1,308	68,329	1,180	45,766	732	1,102
5-23-53	6,360	6,983	278,290	3,237	152,403	303	22,003	1,393	66,776	1,193	40,629	681	1,092

Source: Data for last two months from API; prior monthly data from Bureau of Mines.

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Meet Our Authors . . .

J. R. Suman E. G. Jackson O. C. Mudd J. B. Armstrong F. W. Winn F. Heinemann H. Heinemann H. Groppe

Suman Began Early to Follow Father's Advice

John R. Suman, "Growing a Good Executive Crop," page 114.

Early in his life John R. Suman was told by his father that he was going to have to work for himself, as he, the elder Suman, was going to retire and spend what he had accumulated. And work John Suman has.

From making wooden egg crates to working at every type of engineering involved in the production end of the oil industry, he has pursued success with such verve as to render his father's admonition superfluous.

Technological achievement has been his main contribution to the industry. Early in his career he switched from eggs to equipment and soon found himself in a leading role in the development of the modern rotary drilling rig. Another gold star was added to his record when he worked with Humble Oil & Refining Company, which he is credited with helping develop.

Suman made another rewarding switch in his career in 1945, becoming vice president and director of Standard Oil Company (New Jersey). Since then he has not only been able to continue his work in production but also to develop groups of younger men in countries in which Jersey Standard has holdings.

Groppe Has Exploited His Unbridled State

Henry Groppe, "The Chemical Industry Looks at LPG," page 141.

Henry Groppe, who for the past two years has been doing long-range planning and development work at Monsanto Chemical Company at Texas City, Texas, makes his maiden voyage this month as an author in this magazine. But it won't be his last if George B. Gibbs, our process and construction editor has anything to do with it.

Editor Gibbs and West, Texas, born Groppe are old friends and have much in common. They attended the University of Texas together, Groppe getting a B.S. degree in chemical engineering in 1946, they spent time in the U. S. Navy together, spent their early careers together, and in 1948 went together to Saudi Arabia with Arabian-American Oil Company.

While in Arabia, Groppe worked as a research and development engineer. At this point the parallel in their lives ended. Gibbs met a girl (whom he later married) while Groppe continued in his unbridled state.

On his return from Arabia in 1951, Groppe joined Monsanto, working as a group leader in the Process Design and Evaluation section before getting his present assignment.

If you're ever in Galveston, Texas, and you meet a tall, well-built young man who has an easy way of expressing himself, you're talking to a Texan. If the man is an officer and active in theater and art groups and in the Galveston Unitarian church, you're talking to a busy Texan. If he's active in Galveston bachelor groups and is sometimes known as the "Squire of Galveston," you're talking to Henry Groppe.

Jackson Has Unusual Hobby: Five Women

E. G. Jackson, "Foundations for Self-Supporting Towers," page 145.

This design engineer in the Structural department of The Lummus Company is a Texan born and bred. His education pattern is familiar to those who weathered the war years. He got in three years at the University of Texas before entering the U. S. Armed Forces. Returning to Texas after being discharged, he earned a B.S. degree in civil engineering and went to work for the State Highway Department, first in the field and then in the Bridge division. Soon afterwards he joined Lummus. Emmett G. Jackson's hobbies: five women—his wife and four energetic daughters ranging in age from four and a half to one.

Hays Teaches What Management Needs

Robert Hays, "Communications Make the Manager," page 119.

This English Department head and assistant professor at Southern Technical Institute, Chamblee, Ga., teaches business correspondence, technical writing and public speaking. All three are subjects which should be within management's kenning.

Robert Hays has been the commercial manager of two radio stations, a radio announcer, and supervisor in charge of preparation of training manuals and training courses for an aircraft plant. He has written numerous articles on communications and technical education.

Winn's Wife Promoted Increase in His Hobbies

Francis W. Winn, "Equilibrium K's by Nomograph," page 131.

This associate technical director at Fractionation Research, Inc., is a native Oklahoman and was graduated from the University of Oklahoma in 1940 with a B.S. degree in chemical engineering. After graduation he was with Pan American Refining Corporation, the Refining division of Petroleum Administration for War, the Research and Development division of Socony-Vacuum Oil Company and Catalytic Construction Company. At the last he was assistant chief process engineer. He was at Catalytic prior to joining Fractionation Research.

Winn's hobbies include square dancing (promoted by his wife), woodworking and sailing.

Murdoch and Holland Back After Three Months

P. G. Murdoch and C. D. Holland, "Designing Fired Tubular Reactors," page 163.

Out of a meeting at Texas A. & M. between P. G. Murdoch and C. D. Holland comes this month the second article in three months. Last March, they wrote "Design and Methods for Reactors."

At the time of the meeting, Murdoch was a professor of chemical engineering and had already earned B.S. and Ph.D. degrees at California Institute of Technology; Holland was doing graduate work. Today Murdoch is technical expert with The Dow Chemical Company's Texas division at Freeport; and Holland, who has since received M.S. and Ph.D. from the school, is a member of the Texas A. & M. graduate faculty.

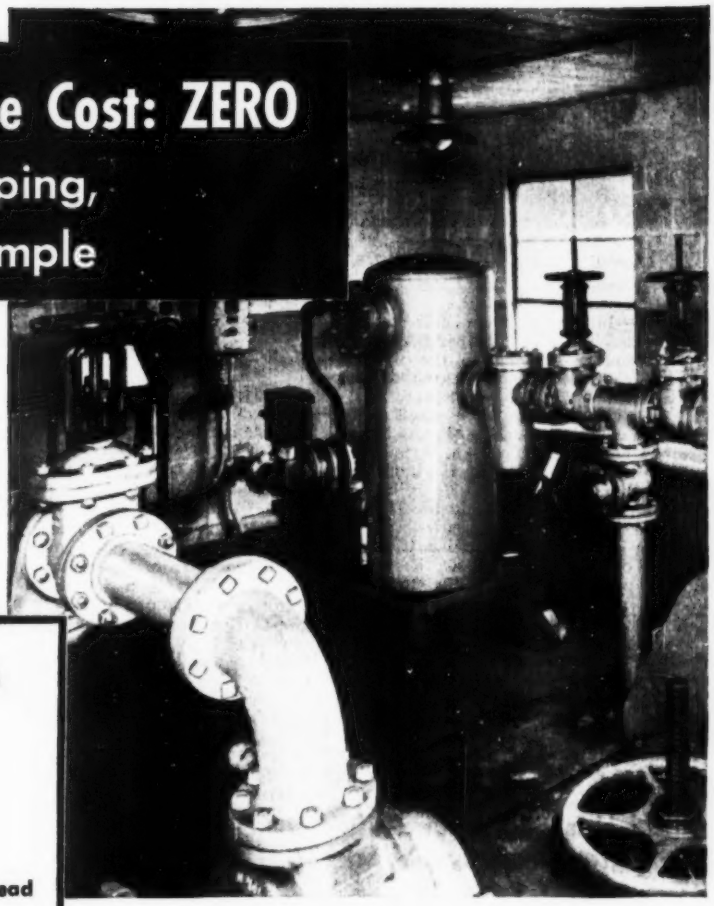
Heinemann and Heinemann —Block and Chip Off It

Felix Heinemann and Heinz Heinemann, "Adsorbents and Catalysts," page 159.

"Like father, like son" is a well-worn cliche that springs back to full meaning when applied to Felix Heinemann and his son, Heinz. Both have a love for chemistry; both have received Ph.D. degrees in the subject; both have written previously for PETROLEUM RE-

Valve Maintenance Cost: ZERO

...on fuel oil piping, for example



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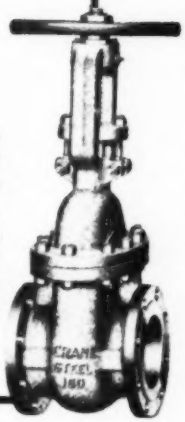

The Case History

Not until the terminal's engineers were convinced of its dependability and low-cost maintenance was any equipment bought for this project. Many similar systems were studied for the best means of assuring utmost economy of operation. The installation was made in 1948 . . . with welded piping where practical, using Crane materials exclusively—steel fittings, check valves, and No. 47X, 150-Pound steel gate valves.

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E. B. Chiswell J. J. Merrill E. B. Field C. H. Homer S. Kopp R. A. Feagan, Jr. H. L. Lawler M. H. Rahmes

FINER—but have never collaborated on an article for this publication.

The senior member of the writing team earned his Ph.D. degree at the University of Berlin. As a patent attorney in Germany he represented many famous scientists, among them Franz Fischer and Hans Tropsch. Afterward he spent several years in England and then moved to the U. S. He is now a consultant chemist and chemical engineer, residing in Morton, Pa.

Heinz Heinemann, familiar to most readers of this magazine as the editor of the patent digest section formerly carried, received a Ph.D. degree from the University of Basle, Switzerland. German by birth, he came to the U. S. in 1938 and has since worked as research chemist for several organizations in the petroleum industry. For a year he was a member of the Carnegie Institute of Technology faculty. He is at present a section chief at Houdry Process Corporation.

Mudd Has Background of Underground Storage Work

O. C. Mudd, "Avoiding Underground Corrosion," page 172.

One of the world's leading experts on underground corrosion, O. C. Mudd has followed this field ever since 1933, when he assisted in the first organized corrosion investigation on Shell Pipe Line Corporation's pipe line system. In this time he has pioneered many advancements in the field.

In 1925 he became superintendent of construction for a construction firm and within three years was a member of the Shell organization.

Field Has Won Honors in High School and College

Edward B. Field, "Reduce Clay Dosages by 50 Percent," page 149.

Edward Bell Field is a junior at Texas A & M College, majoring in chemical engineering. His experience in the field includes summer work in Sun Oil Company's Geophysical department in 1951 and 1952 and in Magnolia Petroleum Company's Technical department last year. At Texas A & M, his academic abilities won for him selection as a distinguished student in his freshman and sophomore years.

His athletic abilities in high school earned for him letters in track and football and have led him into hobbies of handball, pistol target shooting, hunting and fishing.

Meet Our Authors. . .

Homer and Kopp Apart But Work at Same Place

C. H. Homer and S. Kopp, "Air-Cooled Industrial Heat Exchanger," page 151.

Both C. H. Homer and S. Kopp are with American Locomotive Company. But while Homer is at Beaumont, Texas, as plant manager, Kopp at the Alco Products plant at Dunkirk, N. Y., as chief consulting engineer.

Graduated from Rice Institute, Houston, in 1937, with a degree in chemical engineering, Homer became a metallurgist at Beaumont Iron Works Company one year later. When the company became an affiliate of American Locomotive in 1946 he was appointed plant superintendent. Three years later he was transferred to the Dunkirk plant, becoming chief quality control engineer and, two years later, project engineer for air-cooled heat exchangers. A year later he was returned to Beaumont.

Kopp has been with American Locomotive since 1928. He received his mechanical engineering degree from New York University.

Armstrong Migrated to California in 1939

John B. Armstrong, "Corrosion Investigating Techniques," page 176.

As test engineer for natural gasoline operations, Producing department of Standard Oil Company of California, John B. Armstrong does process engineering and plant testing for the Taft area, Northern district. He also assists the superintendent of natural gasoline operations in coordinating process and product control operations.

An alumnus of Ohio State University, B.Ch.E. degree in 1937 and M.S. in 1938, he migrated to California in 1939 to work as a chemist for a vitamin and pharmaceutical company. He joined California Research Corporation as a research engineer in 1945, transferring to the former natural Gasoline department as a test engineer for the Southern district in 1948. In 1951 he was moved to his present position in Taft, Calif.

Stanolind Trio Arrived in Three Successive Years

R. A. Feagan, Jr., H. L. Lawler and M. H. Rahmes, "Operating Experience with Amine Units," page 167.

One after another, these three authors joined Stanolind Oil and Gas Company in Tulsa; Feagan in 1946 as process engineering supervisor in the general office Lawler in 1947 as a chemical engineer in the Research department, and Rahmes in 1948 as junior process engineer in the general office.

Feagan, a graduate of the University of South Carolina, with a B.S. degree in chemical engineering, was named chief process engineer in 1950, and the following year was advanced to plant engineering supervisor.

Lawler holds a B.S. degree in chemical engineering from the University of Colorado and is presently doing work on his masters at the University of Tulsa. Since joining Stanolind, he has been a refinery engineer at the company's Superior refinery at Vivian, La., plant and operating engineer at the Elk Basin unit plant, and plant and operating engineer at the Slaughter gasoline plant near Sundown, Texas. He was returned to Tulsa in 1951 as a mechanical engineer in the general office.

Rahmes received a B.S. degree in chemical engineering from the University of Cincinnati. Following a five-year stint in the U. S. Army he enrolled at the University of Tulsa, winning an M.Sc. degree in petroleum refining in 1947. Three years after joining Stanolind he was named senior process engineer.

Chiswell and Merrill Find Mutual Interest in Work

E. B. Chiswell and John J. Merrill, "Capital Cost Considerations," page 127.

During spare hours E. B. Chiswell likes boating and John J. Merrill likes botany, but when it's time for business their interests converge. At California Research Corporation, they are concerned with carrying on process designs on all chemical and petrochemical projects in their company.

Chiswell joined the Research and Development department of California Standard in 1937, shortly after receiving a Sc.D. degree from Massachusetts Institute of Technology, where he had previously earned B.S. and M.S. degrees. When the Research and Development department later became California Research Corporation, he continued in process design and today is chief process engineer. He spends his summers and as many week ends as possible on Tomales Bay.

Merrill also joined California Standard in 1937, soon after being graduated from the University of Washington with a B.S. degree. He was transferred to the Research and Development department shortly after joining the company and today is with California Research, in charge of process design and related engineering work. His hobby is amateur orchid growing.

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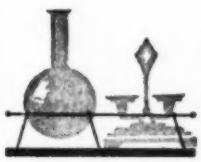

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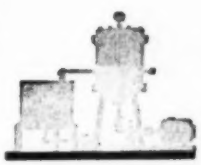

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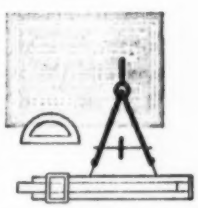

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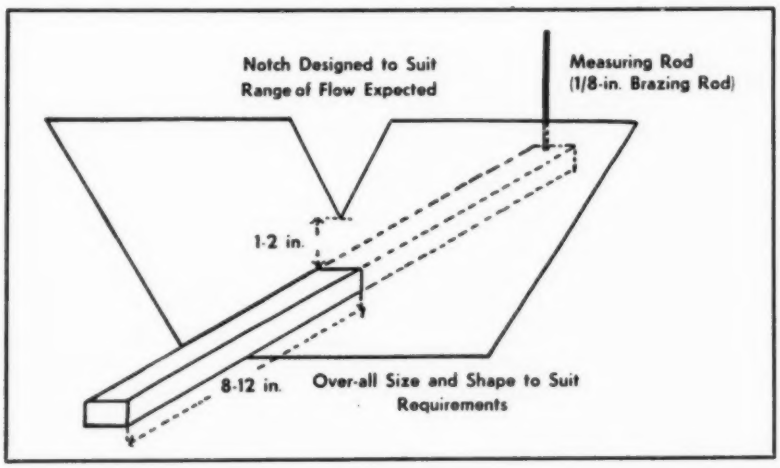

Figure 1

Portable Wier Measures . . .

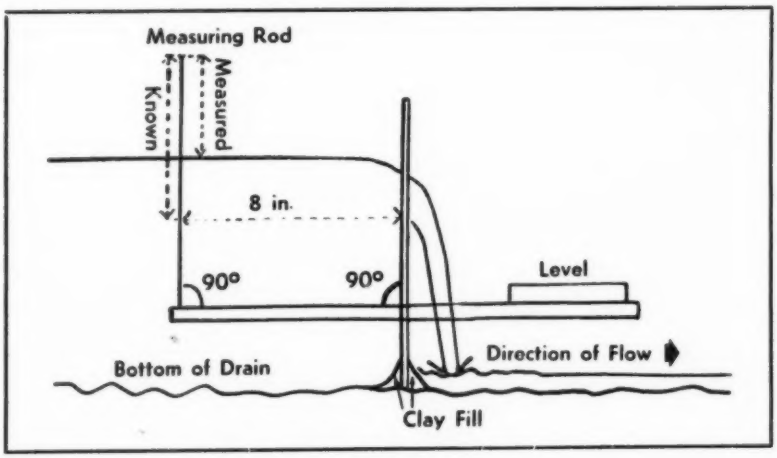

Figure 2

. . . Flow in Drains

Getting accurate and quick measurements of flow rates of drains and ditches around plants need not be difficult. Here's an easy way to do it.

OFTEN IT is necessary to know accurately the flow of water or effluent in a ditch or drain where permanent flow records are not required. With well constructed ditches this can usually be done easily but when sides and bottom are irregular some special device must be employed.

The wier illustrated in Figure 1 has been found very suitable for the purpose. With two such wiers of different sizes, a full flow survey of 12 different drains was completed with the expenditure of a fraction of the time and effort initially expected.

Design and Installation—The external size and shape of the wier can be arranged to suit the ditches or drains to be metered; semi-circular, rectangular and trapesoidal (see Figure 1) shapes have been found to be most suitable. The most convenient method of installation is to seal the edges of the wier in place with clay after narrowing the flow if necessary with a small wall of clay-sealed bricks, some support being given to the wier plate on the down stream side to counter the pressure of water. Generally the out-fall of the drain is the most convenient site as there is normally more fall there, and this reduces the time required for the water level to rise and to come to equilibrium behind the wier. However, it is essential that there is not too much fall or the required steady flow conditions above the wier will not be obtained and the measurements can be in error.

How It Works—By placing a portable level on the downstream end of the horizontal bar as shown in Figure 2 the wier is readily adjusted so that the bar is truly horizontal. This ensures not only that the wier plate is vertical if properly constructed but also that the top of the measuring rod is at a constant known height above the bottom of the wier overflow so that it can be used to measure the head of water. In this manner the measuring rod on the upstream side enables the head to be measured accurately without disturbing the flow. The emergent length of the rod can be measured readily with a rule or, if desired, the rod can be engraved directly with a suitable scale.

The wier opening or notch can be varied to suit the range of flow rates expected. Normally the use of a V-notch gives a greater range, particularly with small flow rates. Under other circumstances, however, a rectangular notch can be of greater service.

In some cases it may be convenient or even necessary to weld some "feet" on the wier to give stability. In other cases such "feet" may prove a handicap in providing a stable wier because of irregularities in the bottom of the drain.

This idea was submitted by George Mapstone of Satamar, Boksburg North, Transvaal, Union of South Africa.

How to Do It Continued on Page 188

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EQUIPMENT RECOMMENDATIONS
Specification and furnishing of additional equipment when necessary, including complete analysis of savings and benefits made possible.

PLANT STAFF INSTRUCTION
Experienced technicians instruct your personnel in accurate control and test procedures.

PERIODIC CHECK-UPS
Personal call-backs to your plant by a Bird-Archer Service Engineer to assure best possible results.

WRITE FOR LITERATURE

ENGINEERING PLUS CHEMISTRY
EQUAL BIRD ARCHER SERVICE
For Power For Process For Cooling

BIRD-ARCHER
WATER TREATMENT
THE BIRD-ARCHER COMPANY 4337 N. AMERICAN ST., PHILADELPHIA 40, PA.
NEW YORK • CHICAGO
IN CANADA The Bird-Archer Co. Limited, Cobourg, Ontario
BIRD-ARCHER COMPANY OF CALIFORNIA, San Francisco

How to Do It . . .

Wooden Dispatching Box Aids Material Handling

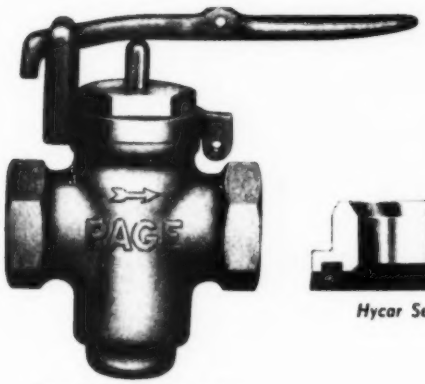
The dispatching rack shown in the photograph has proved a useful device for aiding material handling in one mechanical shop. There is a box for each of the major divisions of crafts.

Each box is sturdily constructed of wood and palletized for use with fork lift trucks. All outgoing supplies are tagged to indicate their destination and placed in the appropriate craft's box. The insertion and removal of the pallets is easily accomplished with fork lift trucks.

Novel Spool Piece Makes Precision Welding Easier

The welding positioner shown in the illustration features a novel spool piece. The automatic welding head moves to any angle and is easily rotated. Operated by a hand powered gear attachment, the device requires very little physical ex-

PAGE* SAMPLING VALVE



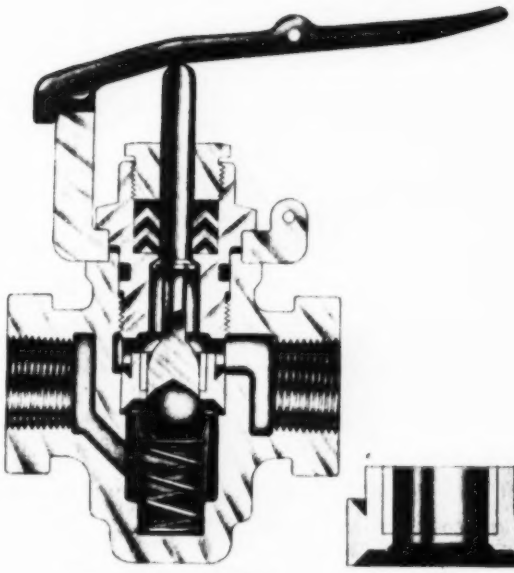
Type "A" Sampling Valve

Hycar Seat

1. Refinery and Industrial Uses

2. Manual or Automatic Shut-Off

3. Sampling Under Line Pressure



Type "B" Sampling Valve

Teflon Seat

Here is the most modern Sampling and Shut-Off Valve on the market today. This is an all purpose valve, ideal for both laboratory and field applications from blowing tubes in the refinery to serving as an automatic shut-off on fire protection equipment. For Butane-Propane lines, gas and liquids of all types, for stationary and portable installations, the valve is extremely versatile in its adaptation.

The Page Sampling Valve serves both as a means for sampling under line pressure and for complete shut-off either manually or automatically. Sampling is done simply by depressing the handle only enough to crack the valve seat. Full flow is attained by depressing the handle all the way. The seat assembly as illustrated can be furnished in Hycar or Teflon.

THE NAME TO LOOK FOR ON OIL TOOLS

The valve handle which can be rotated 360° is drilled and tapped to accommodate a fusible link commonly used for automatic shut-off fire protection.

Complete catalog and prices available upon request.

PATENT APPLIED FOR

* REGISTERED U. S. PATENT OFFICE

PAGE

OIL TOOLS, INC.

3356 LIME AVENUE

LONG BEACH 7, CALIF.

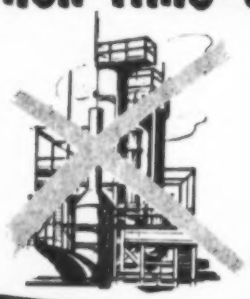
Distributors

BEN W. BRUNDAGE
3871 Piedmont Avenue
Oakland 11, California

HOWARD W. JOHNSON
30 Church Street
New York 7, N. Y.

For more data on advertised products, use Readers' Service Cards, last page.

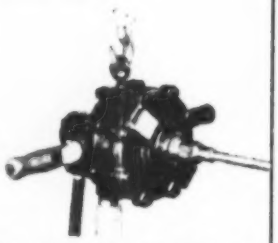
When time-out takes heavy toll



...TRY LAGONDA

The famous Lagonda 1100 Series refinery cleaner, with the Type UO head. This combination is tough on coke.

AUTOMATIC SIGHT FEED LUBRICATOR controlled entirely by pressure. Simple and positive.



FOR CONDENSER AND HEAT EXCHANGER TUBES. Direct-drive air-driven cleaner using shaft and drill heads, the motor supported outside the tube by overhead pipe. Motor has trigger control. Also available with electric motor.

CATALYST CLEANER. Removes spent catalyst from tubes, without permitting its escape.

Do you feel that your clean-outs should go faster? Put it to the test — have your nearest Lagonda tube cleaning engineer check the kind of coke your stills develop, recommend the cutter head best qualified to handle it, and put that cutter head to work backed up by a powerful Lagonda 1100 Series refinery motor. *There's* a combination that will give you a close idea of the minimum time your clean-outs should require. It's a procedure that during the past quarter-century has given a good many refinery executives new ideas about the time-saving possible in clean-outs, and gotten literally thousands of stills back on stream many profitable hours sooner than before. Try Lagonda—there's nothing to lose and everything to gain. Phone your nearby Lagonda man or write Elliott Company, Lagonda Division, Springfield, Ohio.

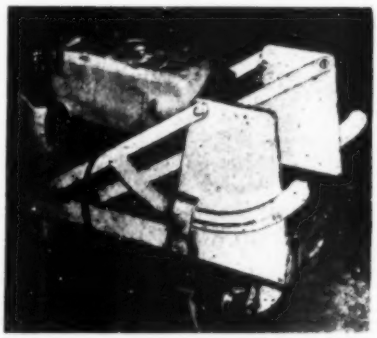
ELLIOTT Company

Y4-6

STEAM TURBINES • MOTORS • GENERATORS • DEAERATING HEATERS • EJECTORS • CONDENSERS • CENTRIFUGAL COMPRESSORS • TURBOCHARGERS • TUBE CLEANERS • STRAINERS

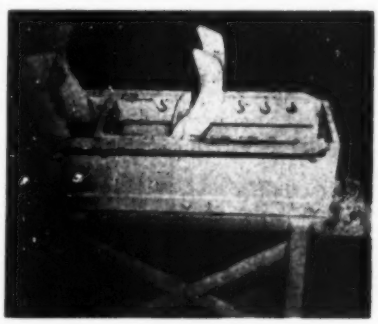
How to Do It...

ertion. The spool piece bolted to the center of the positioner decreases in diameter from about 14 inches at the point of attachment to the positioner down to 10 inches at its outer end. Clamps fit through the notched portions of the spool and are held in position with thumbscrews. As the table is rotated, the welding device maintains a rigid line around the spool. The device is highly useful for building up metal thicknesses on parts that will subsequently be machined.



Mobile Cart Facilitates Pipe-Bending Operations

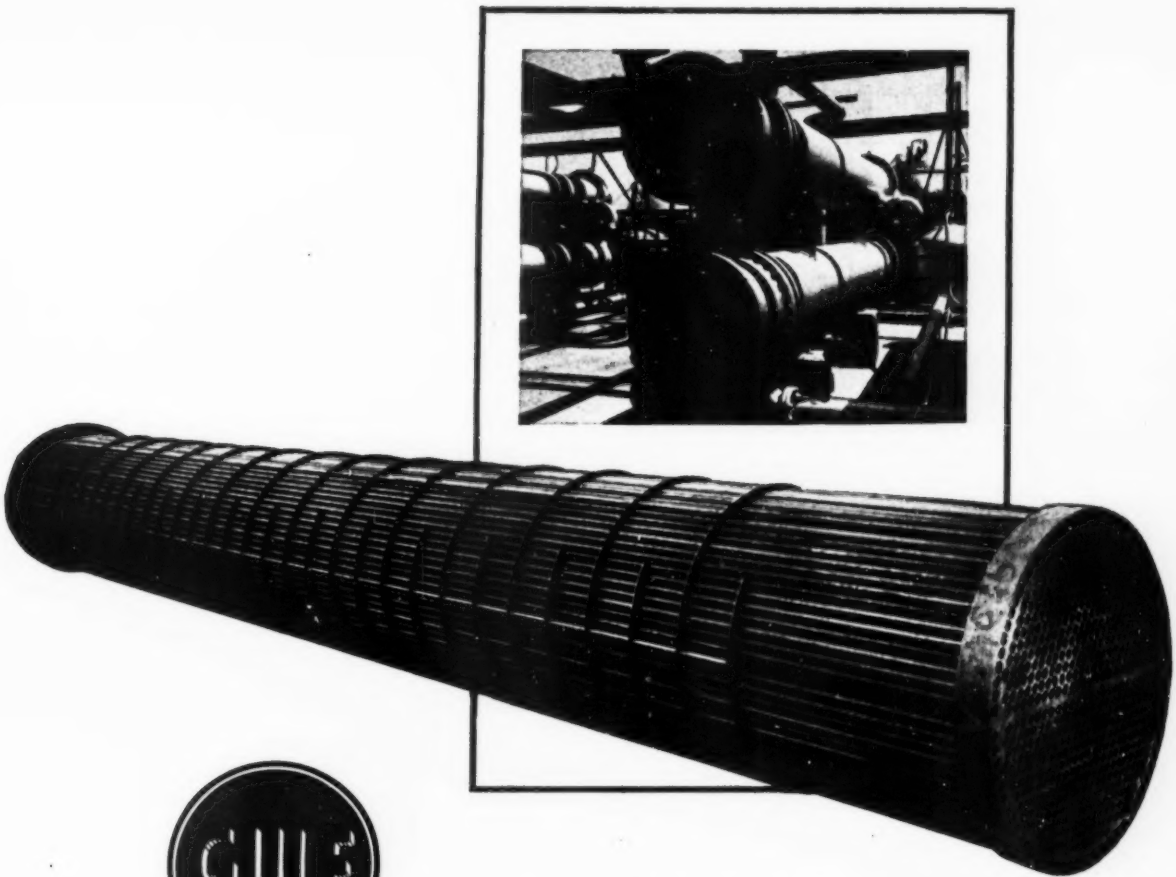
The cart is constructed of sheet steel, cut to the desired shape with a welding torch. The pipe-bending apparatus can be rotated through an angle of about 20 degrees by adjusting the hand crank shown in the foreground. The well braced cart is mounted on heavy steel casters to enable easy movement around the shop. The pipe-bending apparatus is fitted with a handle to permit fine adjustments on the location of the cart.



Versatile Clamp Speeds Valve and Pipe Handling

The shop-fabricated clamp shown in the accompanying photograph has greatly improved equipment handling at one major refinery. Easily constructed from half-inch sheet steel, the clamp has a wide variety of uses.

The clamps are fully adjustable for



GULF uses ELECTRUNITE

Heat Exchanger Tubes

In fact, ELECTRUNITE Tubes have been in Gulf heat exchangers for the past twenty years, helping to keep refinery processes on-stream.

This kind of dependability begins with the steel used in Republic ELECTRUNITE Tubes. Made in Republic's own mills, its quality is controlled from ore to finished tubing.

Ductility is controlled for uniformity. Corrosion resistance is uniform all around the tube, from end to end. And full normalizing in controlled atmospheres assures clean, scale-free surfaces.

These advantages can add up to this:

1. **Longer time between re-tubings**
2. **More hours of production with less down time**
3. **Lower cost per year**

These facts have been proved not only by Gulf, but by the millions of feet of ELECTRUNITE Heat Exchanger Tubes used in thousands of heat exchangers in scores of industries. You can find more facts in Booklet CEC-54. Write for it.

REPUBLIC STEEL CORPORATION
Steel and Tubes Division
220 E. 131st Street, Cleveland 8, Ohio
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, N.Y.

REPUBLIC STEEL

ELECTRUNITE

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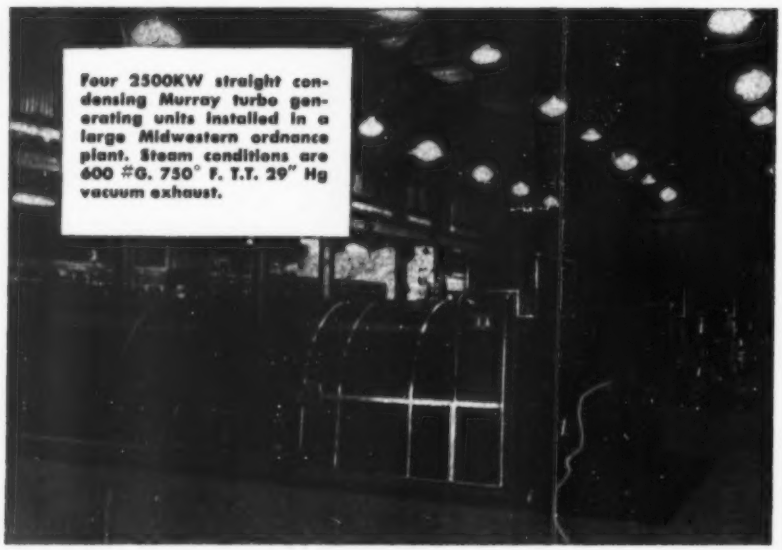
Murray Turbines



Four 2500KW straight condensing Murray turbo generating units installed in a large Midwestern ordnance plant. Steam conditions are 600 #G. 750° F. T.T. 29" Hg vacuum exhaust.

● Murray Turbo Generator units can be furnished to meet your special requirements in sizes up to 3000KW. Condensing and non-condensing types with or without extraction and/or mixed pressure features can be furnished. Whether you require a small inexpensive standby unit or a highly efficient, and reliable source of power, Murray has a design to fit your needs. Consult your local Murray representative who will gladly help you select the unit most economically suited to your conditions.

MURRAY IRON WORKS COMPANY
BURLINGTON, IOWA

Builders of Steam Power Equipment for Three Quarters of a Century

How to Do It...

the size of the material to be handled, which may vary from the extremes of control valves to 6-inch pipe. The supporting table is notched at 2-inch intervals to provide the major adjustment. The final minor adjustment is accomplished by the threaded screw shown.

The clamp foundation is four feet long by 18 inches wide. The clamp foundation is firmly mounted to a supporting table. The table is equipped with casters to ensure complete mobility in and around the shop.

Drill-Reamer Unit Ends Tube Pulling Difficulty

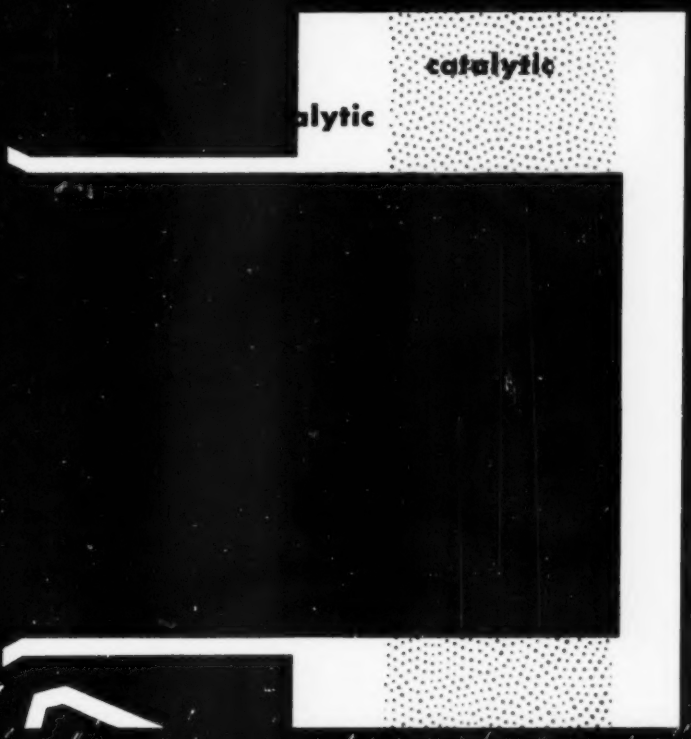
Getting tubes from tube bundles has been the bane of busy maintenance men for years. In the very ingenious device shown above, a power drill and reamer are used together to banish the bane by removing single tubes from a tube bundle without ever having to pull the bundle from the exchanger. The device makes possible replacement of a leaking tube in a matter of minutes rather than hours, and with the accompanying process credit. Here's how it works.

First, the exchanger head must be pulled. Then the tube is cut loose from the tube sheet with the proper size spiral fluted drill. This must be done on the tube sheets at both ends of the exchanger bundle. The photograph above shows a power drill equipped with the special fluted drill and—for illustrative purposes only—shows another drill inserted into one of the tubes. After the fluted drill is used to cut the tube loose, all that remains is to use a hand tamp to knock the tube loose from the tube sheet. There you have it, it's as simple as that. A tube is pulled from a bundle in less time than it takes to tell how to do it.

processes

petroleum refining

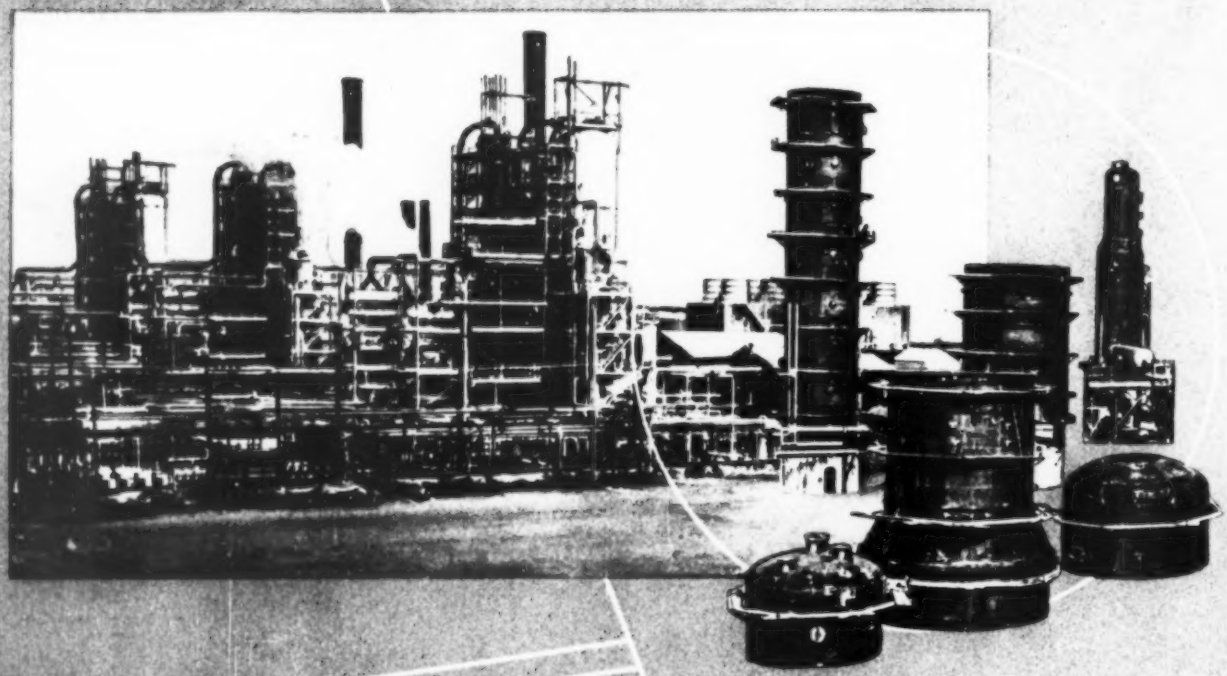
petrochemical



FOSTER WHEELER

builds them all

three in line



one coming up

Over 300,000 barrels per day will be the capacity of this two-stage crude distillation battery when the fourth unit is placed "on stream".

Foster Wheeler designed and constructed all four units for this major Gulf Coast refiner.

For a general description of the flow of crude and products thru these units . . . write for HE-12-51.

FOSTER WHEELER

165 Broadway, New York 6, N. Y.

New Books . . .

Choice of the Engineer

Chemical Engineering in Practice, edited by James I. Harper, Reinhold Publishing Company, New York 36.

In this age of specialization, chemical engineers no less than people in other fields are faced with choosing the specialized endeavor they will take up.

The American Institute of Chemical Engneers saw that young engineers (as well as some older ones, too) needed assistance in choosing. To this end, the Philadelphia-Wilmington section of AIChE and the Department of Chemical Engineering, University of Pennsylvania, sponsored a symposium entitled "Chemical Engineering in the Process Industries." This book is based on that meeting, at which eight successful engineers "sat down" with less experienced engineers who have had no opportunity to participate in many projects and presented the "tricks of the trade."

To present the picture of chemical engineering in its many phases, the speakers covered a number of processes in a number of industries. But as R. A. Kinckiner, general chairman of the meeting said in his introduction, "Sharp, precise dividing lines cannot be drawn between . . . various phases of engineering or, for that matter, between various phases of processing . . . what you hear today is not a natural, inflexible organization of engineering activity, but one which certain groups have found convenient and workable."

The purpose of the chemical engineer, says the editor in his introduction, is to create wealth or to create the opportunity to make wealth. To show how the engineer goes about doing this in the process industries, the speakers trace a process from its inception through all its steps, each influenced heavily by chemical engineers. Logically, the editor points out, this should show what chemical engineers do, how they do it and what value they have.

Industry Accounting

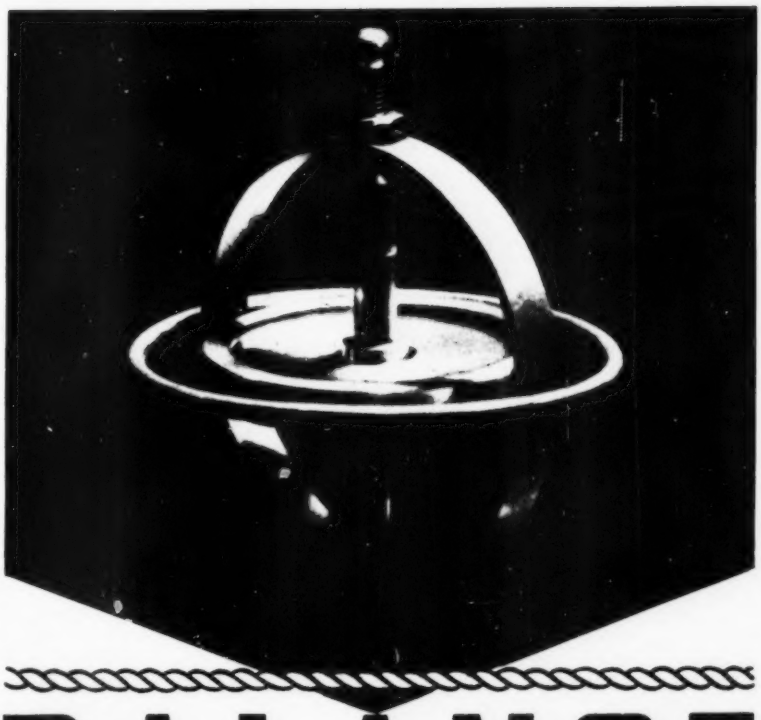
Outline of Petroleum Industry Accounting, American Petroleum Institute, 50 West 50th Street, New York 20. $3.

Compiled by the Accounts and Accounting Procedures Subcommittee of API, this manual is designed as a reference book for companies having established procedures, and as a guide book to help new employes obtain an over-all perspective of industry practices.

It can also be used by libraries and education institutions in meeting requests concerning petroleum industry accounting procedures, and by colleges and universities as supplemental information for accounting courses.

The manual covers nine basic functions of petroleum operations: producing, natural gas processing and cycling; pipe line; crude purchasing and storage; refining; tank car; marine; marketing; and administrative. A chart of accounts is also included.

In the introduction the subcommittee points out the book is to be viewed only as an outline.



BALANCE

For *true worth* the cost of industrial insulating materials and installation should be balanced against the efficiency and life of the insulation.

First cost may be a deceptive indicator of insulation value. You may spend double the amount necessary and not get your required protection. On the other hand, the lowest bid can be the costliest.

Mundet has a closely integrated, experienced, nationwide organization. Our engineers will survey your plant to see that the necessary lines and equipment are insulated with the *right material* and the *right thickness* to provide greatest economy and longest life.

The value of Mundet service can be easily demonstrated. The quality of Mundet insulating products is guaranteed. Mundet Products cover every temperature requirement from minus 200°F. to plus 1900°F. One of our newest products is WATER RESISTANT 85% magnesia designed to protect hot piping and equipment from water exposure damage. Send coupon for information on this and other Mundet products.

There's a Mundet Office near you

ATLANTA, GA. 339 Elizabeth St., N. E.
BALTIMORE 30, MD. 100 S. Charles St.
CINCINNATI 2, OHIO 427 West Fourth St.
DALLAS 10, TEXAS 601 Second Ave.
DETROIT 21, MICH. 14401 Prairie Ave.
HOUSTON 11, TEXAS 6601 Supply Row
INDIANAPOLIS 3, IND. 1250 Beecher St.
JACKSONVILLE 6, FLA. 800 East Bay St.
KANSAS CITY 1, MO. 1210 West 9th St.
LOS ANGELES, CAL. (Maywood) 6116 Walker Ave.
NEW ORLEANS 16, LA. 315-325 North Front St.
NEW YORK 17, N.Y. 331 Madison Ave.
PHILADELPHIA 39, PA. 856 North 48th St.
ST. LOUIS 9, MO. 3176 Brannon Ave.
In Canada: Mundet Cork & Insulation Ltd. 35 Booth Avenue, Toronto

MUNDET CORK CORPORATION, Insulation Division
7103 Tonnelle Ave., North Bergen, N. J.

Send information on Mundet Industrial Insulations.

NAME .....

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ADDRESS .....

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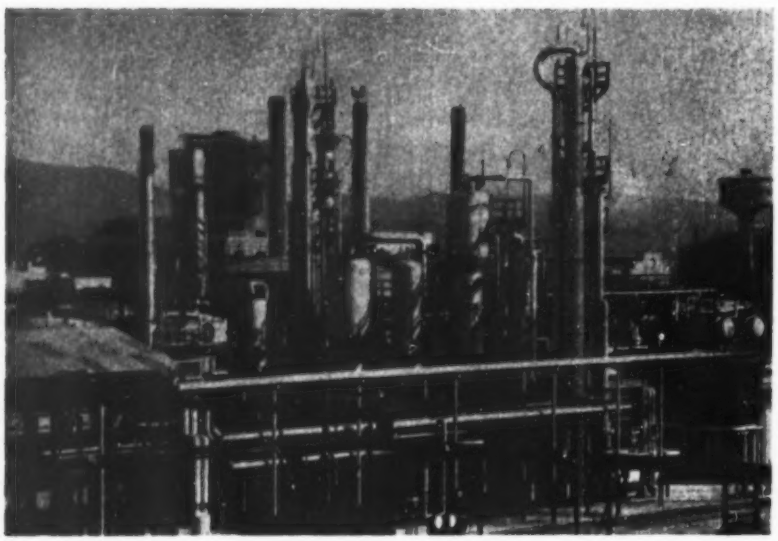
Who's Building . . .



STANIC Inaugurates Livorno Refinery—
Two million tons of crude oil will be produced by this reconstructed refinery of Stanic Industria Petrolifera, recently opened at Livorno, Italy. The refinery, completely destroyed during the last war, was erected by STANIC, a company created by an agreement between Standard Oil Company (New Jersey) and ANIC, an Italian government company. The new refinery will process a large variety of petroleum products, including high-octane gasoline and lubricants.

Gulf Will Add Platformer To Cincinnati Refinery

Contracts have been let for the construction of a platforming catalytic reforming unit and auxiliary units at Gulf Refining Company's Cleves refinery at Cincinnati, Ohio. Procon Company, Des Plaines, Ill., was awarded the platforming contract and will begin actual construction in July.

The new unit will have a capacity of 10,000 barrels a day and will use platinum as a catalyst. It will take low-octane naphtha and up-grade it into high-octane gasoline. It will also be capable of making benzine, toluene and zylene. A boiler and cooling tower will be constructed as auxiliary units for the platformer.

The work, to be completed by April 1, 1955, is part of a $250 million capital expenditure program at Gulf for this year.

Canadian Oil Starts Up Montreal Lube Oil Plant

Production has started at Canada's highest speed lubricating oil and grease manufacturing plant. Built for Canadian Oil Companies, Ltd., to replace its predecessor which was destroyed by fire a year ago, the new plant, located at Montreal, is equipped with the fastest oil filling line in Canada.

Mississippi River Fuel Plans Petrochemical Unit

Construction of a $15 million petrochemical plant by Mississippi River Fuel Corporation on the Mississippi River is expected to begin sometime this year. The project will be located on a 4500-acre tract 35 miles south of St. Louis.

Mississippi River Fuel and Mathieson Chemical Company early in 1953 formed a jointly owned subsidiary, Mathieson Mississippi to study the possibilities of petrochemical production. This joint venture has since been dissolved, but Mississippi River Fuel announced earlier this year that it was continuing consideration of constructing the facilities on its own.

Pan American Ups Output Of Proposed Refinery

Decision has been made by Pan American Refining Corporation to increase the initial daily capacity of the multimillion dollar refinery it plans to build near Yorktown, Va. Revision of the refinery design provides for an initial capacity of 35,000 barrels a day, as compared with the originally planned 25,000 barrels a day.

Pan American, manufacturing affiliate of American Oil Company, expects to award the general construction contract for the refinery late this year. Wiley N. Jackson Company, awarded the initial contract for clearing a portion of the 1200-acre site, has begun work. Clearing should be completed within six weeks.

Texaco Project Heads ODM List of Write-Offs

Top project on the Office of Defense Mobilization's latest list of refining and related projects approved for rapid tax amortization was the additions which The Texas Company will make to its Port Arthur, Texas, refinery. ODM allowed Texaco to deduct 45 percent and 65 percent of portions of the $11.4 million the company will spend on construction of the additions from its taxable income over a five-year period instead of the longer period normally required.

Aurora Gasoline Company, Detroit, placed second, getting 15 to 65 percent of $5,365,000 for petroleum refining facilities.

Other projects on the list, with location, facility, total cost and amount certified, were:

Kerr-McGee Oil Industries, Inc.—Pampa, Texas, expansion of the company's natural gasoline plant to process an additional 2.5 to 3 Mmcf of natural gas a day into 143 barrels a day of liquid hydrocarbons and 18.5 Mmcf a day of sweet residue, $550,000: 65 percent on $520,000, and 25 percent on $30,000.

Sun Oil Company—Marcus Hook, Pa., construction of 15,000-barrel-a-day catalytic reformer and related facilities, $4,750,000: 65 percent on $4,400,000 and 45 percent on $350,000.

B-A Plans Another Hike In Capacity at Clarkson

Another expansion of the capacity of its Clarkson, Ont., Canada, refinery is planned by British American Oil Company. Capacity of the Clarkson refinery will be boosted from 17,000 to 20,000 barrels a day when a new catalytic cracking unit goes on stream next month.

The new capacity is about all the company expects to get from the existing topping units, which were originally designed to run 8250 barrels a day. Plans are currently being made to build an additional topping unit since the new cat cracker is capable of handling charging stock almost double the amount of the refinery's present crude capacity.

B-A also plans to award contracts shortly for reforming units using new type platinum catalysts at its Calgary and Montreal refineries.

California Standard Will Builds Isophthalic Plant

Construction of a multimillion dollar plant designed for the first commercial production of the chemical intermediate "isophthalic" is planned by Standard Oil Company of California. Work on the new plant, to be built at Standard's Richmond, Calif., refinery, is expected to start immediately, with completion scheduled for the middle of 1955.

Oronite Chemical Company, a Stand-

LUMMUS COKING UNITS
give top performance for
Pan-Am Southern

Lummus has built two delayed coking units for Pan-Am Southern Corporation in the past few years, one at El Dorado, Arkansas, and the other at Destrehan, Lousiana... and Pan-Am Southern is well satisfied with them.

The El Dorado unit, despite a 42 day steel strike during the construction period, was completed ahead of the specified date, and for less than the guaranteed maximum cost. It was designed to charge 9,300 B/D of reduced crudes, but since coming on-stream, the daily rate has averaged 10% above the designed capacity. The unit went on-stream immediately and operated 181 out of the first 199 days after completion (a 91% service factor). In the first half of 1953, it achieved and has since averaged a 97% service factor (224 day run, 6 day down-time). On-stream maintenance and repair costs are correspondingly low.

Gas oil from the coker (53% yield of reduced crude charge) is used for catalytic cracking charge stock where its low Conradson carbon allows it to be processed without penalty. Yield structure compares favorably with that obtained from catalytic cracking of virgin gas oil. The coke produced in the process is of sufficiently high quality for use in the manufacture of electrodes for aluminum production.

The new (and similar) Destrehan installation is achieving equally satisfactory records.

Lummus engineers have done an outstanding job for Pan-Am Southern. Why not consult with Lummus on *your* next coking project?

THE LUMMUS COMPANY, 385 Madison Avenue, New York 17, New York. *Engineering and Sales Offices:* New York, Houston, Montreal, London, Paris. *Sales Offices:* Chicago, Caracas. *Heat Exchanger Plant:* Honesdale, Pa. *Fabricated Piping Plant:* East Chicago, Indiana.

LUMMUS

DESIGNING ENGINEERS AND CONSTRUCTORS FOR THE PETROLEUM AND CHEMICAL INDUSTRIES

For more data on advertised products, use Readers' Service Cards, last page.

INSTALL **CAL-FIN** TANK HEATERS

ONE foot of CAL-FIN TANK HEATER tubing has more heating surface and with viscous oils does more work than EIGHT feet of bare pipe of the same size. This means REAL SAVINGS in first cost. The low over-all height permits the fluid level of the tank to be run down as low as 36 inches and still have the heater completely submerged.

For detailed information, write for Bulletin #3005

drayer-hanson
INCORPORATED
LOS ANGELES 1, CALIFORNIA

CAL-FIN Tank Heaters are available in standard sizes up to 1,325 sq. ft., and special sizes up to 6,000 sq. ft.

Who's Building . . .

ard of California subsidiary, will market the production of the new chemical facility, designed to turn out 50 million pounds of isophthalic a year.

Texas Gulf Will Build West Texas Gasoline Unit

Contract for construction of a $2 million natural gasoline plant in the Headlee field of Ector County, West Texas, has been awarded to O. I.. Olsen Company of Houston by Texas Gulf Producing Company.

Initially the plant is to have a capacity to process about 15 Mmcf of gas a day. Engineering provisions will make possible an expansion to 35 Mmcf a day early in 1956. Construction is to start in July, with the plant expected in operation by the end of the year.

Plant processing will result in an initial output of about 14.3 Mmcf of residue gas. Expected recovery of liquids for sale will be about 1400 barrels a day of natural gasoline and LPG.

Texas Gulf will be the operator of the new plant and will have an 80 percent interest in it. Tide Water Associated Oil Company will own the remaining 20 percent. C. F. Braun & Company, Los Angeles, is the plant designer.

Stanolind Starts Work on West Texas Gasoline Unit

Construction has been started on Stanolind Oil and Gas Company's new gasoline plant in the Midland Farms field, West Texas. The contractor is currently pouring foundations at the plant site. Completion of the installation is expected by early August.

Located on a 40-acre site some 26 miles north of Odessa, the plant will be a compression gasoline plant and will not include absorption or distillation facilities initially. Gas sweetening and gas dehydration facilities will be installed.

Gasoline Plant Construction Corporation has the prime contract for the plant, and Vaughn & Taylor Construction Company, Inc., has been awarded the contract for the field gathering system.

Initially, the compressor installation will give the plant a compression capacity of 10 Mmcf of gas per day. Other facilities are being designed to handle 15 Mmcf per day, and additional compressors may be installed later as development of the Midland Farms field is continued.

Commercial Solvents Will Build Nitroparaffin Unit

Nitroparaffins—a new family of petrochemicals never before available to industry in volume—will be produced at the large-scale facilities Commercial Solvents Corporation is planning to build at Sterlington, La.

In addition, the company will enlarge its existing nitroparaffins operation at Peoria, Ill. The total cost of expansion is estimated at $5 million. Full-scale production is scheduled for the last quarter of 1955.

Initially, Commercial Solvents will make 11 or 12 chemicals in the nitro-

For more data on advertised products, use Readers' Service Cards, last page.

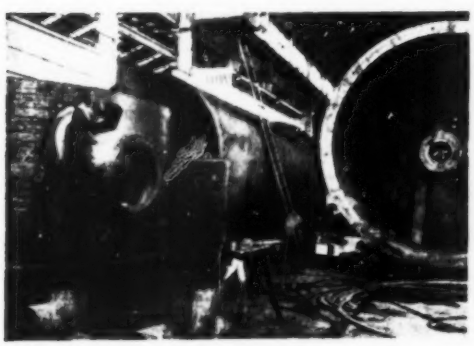
Mud...snow...cold can't slow "package" refinery job

"Bogged" but not "down"— SWECO crews poured foundations, laid pipe lines, conduit, and built structures . . . fighting bad weather and mud all the way. To hold schedule, tons of rock were dumped in the mire to support construction equipment . . . excavations were pumped out day after day . . . straw blankets kept new concrete from freezing. Meanwhile, fabrication of process vessels went ahead in SWECO's own shops.

Despite severe winter weather, construction by SWECO of a "packaged" T.C.C. unit for Bay Refining Corporation, Bay City, Mich., has proceeded strictly on schedule. Fabrication of all heat-exchangers, fractionators and other vessels was completed in SWECO's own shops . . . while experienced SWECO field crews overcame mid-winter snow, mud and freezing weather to finish foundations and structural units on time. Close coordination of shop work with field work makes it possible to schedule completion in *10 months from signing of the contract to "on-stream" date.* The fine combination of pre-engineering, pre-fabrication, and field erection—perfected by SWECO for "package" refinery units . . . is typical of the imagination, ingenuity and reliability which have characterized this company's services to the process industries for more than 25 years.

For design, engineering and construction of complete "package" plants on a turn-key basis or custom fabrication of process equipment, it will pay you to consult SWECO.

Unique "derrick structure" Use of this permanent oil-well derrick type structure for the catalytic section of "package" T.C.C. units was originated by SWECO. It eliminates the need for heavy rigging equipment and substantially reduces cost of both original construction and maintenance. Shown here is a finished T.C.C. unit, engineered and constructed by SWECO for Vickers Petroleum Company, Wichita, Kansas, a nominal 6,000 barrel "package" unit similar to the Bay Refinery job.



Shop-fabrication for field-erection Heat-exchangers, fractionators, pressure vessels and other process units for the Bay Refinery job are fabricated, assembled and pressure-tested in SWECO's own shops . . . then shipped to meet the carefully coordinated field-erection schedule.

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For more data on advertised products, use Readers' Service Cards, last page.

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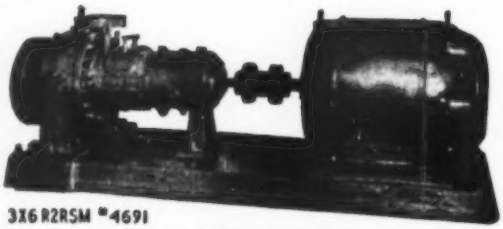
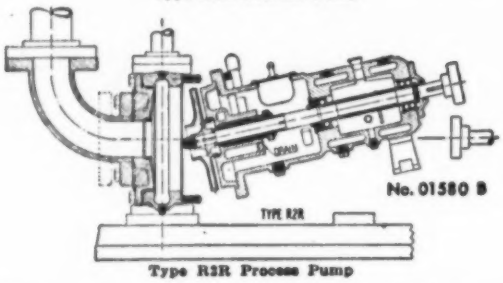
Type R2R Centrifugal Process Pumps



3X6 R2RSM "4691

Type R2R Process Pump



Type R2R Process Pump

DISASSEMBLY: The Type R2R process pumps can be disassembled without disconnecting the suction and discharge piping. By first removing the spacer from the spacer type coupling, and unbolting the casing from the cradle the entire cradle and complete rotating element can be removed without disturbing the suction and discharge piping.

OPERATING RANGE: Type R2R. Heavy duty, process pumps are available in eighteen different sizes, enabling our engineers to furnish units specially designed and constructed for the particular work to be performed.
Capacities: 50 to 2000 Gallons per minute.
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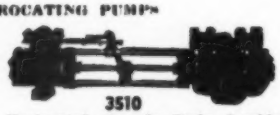
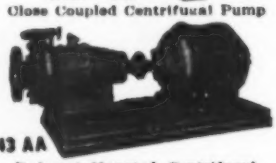


3510

Horizontal, Single Style, Double Acting, Piston Type, Close Clearance Pump. Designed to handle volatile liquids



4043 AA

Pedestal Mounted Centrifugal Pump

3833

Horizontal, Duplex, Double Acting, Side Pot, Piston Type, Oil Bath Power Pump

4728

Double Pedestal Bearing Centrifugal Pump

3554

Durable Duplex Packed Piston Pattern Steam Pump, Side Pot Type

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paraffins group for which there are already established uses. There are, however, about 2000 nitroparaffin compounds, many of which have yet to be completely explored.

Allied Chemical Division Completes One, Starts One

Even as it was completing construction of ammonia production facilities at its new nitrogen plant at Omaha, Nebr., last month, the Nitrogen division of Allied Chemical & Dye Corporation announced another expansion. This one is to be at its Hopewell, Va., nitrogen plant and is to increase production of anhydrous ammonia by 50,000 tons a year.

The Nitrogen division's Omaha plant, first of its kind in the North Central agricultural area, is expected to cost upwards of $25 million when completed. Still under construction are the urea production facilities, and they are expected to be completed shortly. Catalytic Construction Company and The Girdler Company were the two principal construction contractors on the project.

Ammonia capacity of the division's Hopewell plant was increased last year. The new project, involving changes in equipment and installation of some new facilities, will further expand ammonia capacity, as well as capacity for converting ammonia to nitrogen solutions.

Helios, S. A., Will Build Asphalt Refinery in Peru

A group of German investors will finance the construction of a refinery to manufacture lubricating oils, waxes, asphalt and petrolatums at San Andres, Peru. The estimated $8 million plant, to be built on Pisco Bay between Pisco and Paracas by Helios, S. A., will be designed by Hydrocarbon Research of New York.

The plant will have an estimated yearly production of 60,000 tons of lube oils, 10,000 tons of paraffins, 10,000 tons of asphalts and 20,000 tons of combustibles. Completion of the plant is scheduled for early 1956.

Columbian Carbon to Build New Carbon Black Plant

A new carbon black plant will be built by Columbian Carbon Company in St. Mary's Parish on the Intercoastal Canal near North Bend, La.

Construction of the plant was expected to begin right away, with the first unit scheduled to go into operation in November. The project is expected to cost more than $3 million. The plant will have an ultimate capacity of 60 million pounds a years.

Raw materials for the new plant will be natural gas from nearby fields and liquid fractions from Gulf Coast refineries.

Ashland Oil Starts Up New Buffalo Facilities

New facilities for the production of propane and butane gases have been

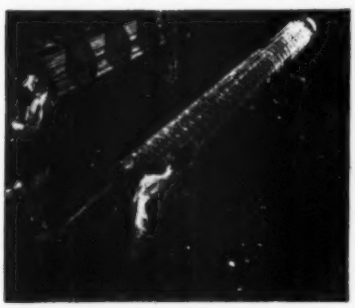
PROCESS EQUIPMENT NEWS

PUBLISHED BY FABRICATED PRODUCTS DIVISION, THE M. W. KELLOGG COMPANY JUNE-JULY 1954

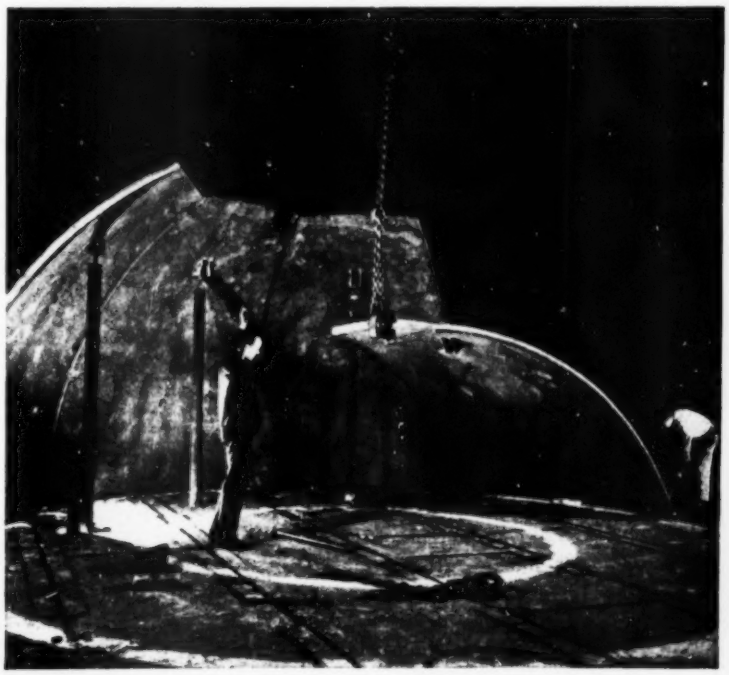
More Fizz for New York's Sodas

More carbon dioxide—for use this summer in carbonated beverages bottled in the New York area—is the worthy purpose behind this condenser, shown below during the tube loading operation in Kellogg's shops earlier this Spring. During the hot weather season it condenses some 30,000 pounds of carbon dioxide an hour, enough to supply the fizz in something like seven million bottles of soda pop.

On the technical side, one of the more unusual service conditions for the condenser is an extreme pressure differential of over 1300 pounds per square inch. Carbon dioxide on the shell side will be held at a pressure of 1400 psig. Water will circulate in the tubes under a pressure of 80 psig. ●



The unit will consist of two shells, each with 250 tubes, ¾ inch in outside diameter by 20 feet in length. The two sections are of forged, integral-channel, fixed-tube-sheet construction with admiralty tubes and steel shell cover, channel, and tube sheets.



Mammoth Pressure Vessel for Oil Refinery to Be World's Heaviest

The world's heaviest process vessel, and one of the largest ever built, is now being fabricated in the Kellogg shops at Jersey City. When completed, the vessel—it comprises the reactor and regenerator of a unique Fluid Hydroforming plant—will stand well over 200 feet high and weigh approximately 650 tons.

Knockdown assembly of certain portions as well as complete fabrication of others will be accomplished in the shop before the various sections are shipped to the field for installation.

The illustration above shows the pressed head sections, cut to exact size, being joined together. The four "orange-peel" sections form half of the bottom head of the vessel. After the other half of the head is fabricated in the same manner, the two halves will be fitted up and match-marked in the shop, then shipped to the job site for final assembly.

The reactor vessel, which will be approximately 135 feet high and have an internal diameter of 23½ feet, will be topped by a smaller vessel, 12½ feet in diameter and 74 feet high, in which catalyst for the reforming process will be regenerated. Over all height of the completed unit, exclusive of the supporting pedestal, will thus exceed 200 feet.

Like the bottom head, the top head and the nine courses for the shell of the large reactor will be shipped to the job site in longitudinal halves. The smaller regenerator vessel will be fabricated in the shop, stress relieved in one of Kellogg's huge furnaces, and shipped to the job site fully assembled. Stress relieving of the welds in the reactor, in itself a job of tremendous magnitude, will be done in the field after the vessel is erected.

The reactor is being fabricated of carbon-moly steel plate, varying in thickness from 2 inches for the top head to 2¾ inches for the lower shell courses and bottom head. Chrome-moly steel plate will be used for the regenerator section.

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SOLUTIONS
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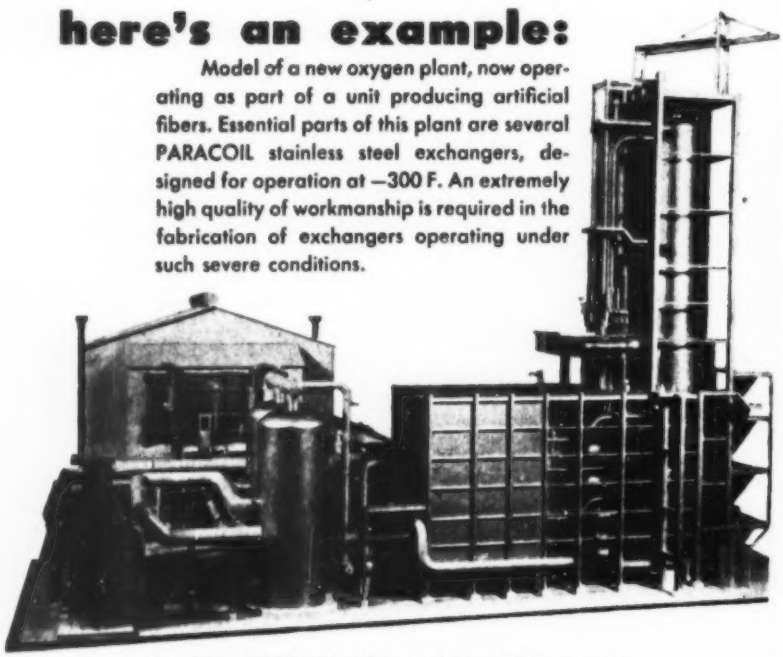
here's an example:

Model of a new oxygen plant, now operating as part of a unit producing artificial fibers. Essential parts of this plant are several PARACOIL stainless steel exchangers, designed for operation at —300 F. An extremely high quality of workmanship is required in the fabrication of exchangers operating under such severe conditions.



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Who's Building . . .

completed and are in full operation at Ashland Oil & Refining Company's recently modernized refinery at Buffalo, N. Y. The Buffalo plant, operated by the Frontier Oil Refining Company Division of Ashland Oil, has added new fluid catalytic cracking and polymerization units and is capable of processing 30,000 barrels of crude oil daily.

Texaco Plans Major Work At Six Different Plants

As part of its capital expenditure program during 1954, The Texas Company plans construction of six new platforming units with a combined rated capacity of 75,000 barrels per day.

The company also plans construction of three alkylation units, a hydrotreater, and an isomerization unit.

These installations will constitute a substantial part of the more than $275,000,000 scheduled for additions to Texaco properties, plant and equipment during the current year.

Refineries affected by the modernization and expansion program are as follows:

The **Port Arthur Works,** Port Arthur, Texas, where construction work has started on the refinery's second platforming unit, which will have a capacity of 20,000 barrels a day. The Lummus Company is handling erection of the unit, scheduled for completion in April, 1955. The refinery's first platforming unit, with a 20,000-barrel-a-day capacity, is expected to be completed early this summer. Other plans for the refinery call for construction of a new 7500-kilowatt turbo-generator, additional tankage, and water cooling facilities.

The **Eagle Point Works,** Westville, N. J., where a platforming unit with a rated charge of 12,000 barrels per day has been under construction for the past month. In addition, work has also been started on an alkylation unit capable of producing 1926 barrels of alkylate per day.

The **Los Angeles Works,** Wilmington, Calif., where a construction program has started which includes the building of a platforming unit, an isomerization unit, a hydrotreater, and the expansion of other facilities. The platforming unit, which will use platinum as a catalyst, will have a capacity of 10,000 barrels of straight run gasoline a day and will be built by C. F. Braun & Company, Alhambra, Calif. The isomerization unit is designed to produce 1000 barrels a day of isobutane; the hydrotreater 10,000 barrels a day of cracked naphthas. Other expansion plans at the Los Angeles Works call for construction of additional steam generating equipment, new tankage and additional water cooling facilities. Scheduled date of completion of the construction program is early summer, 1955.

The **Lockport Works,** Lockport, Ill., where work is slated to begin early this summer on a 11,000-barrel-a-day platforming unit; new alkylation facilities will be built to produce an additional 1000 barrels of alkylate a day.

The **Lawrenceville Works,** Lawrenceville, Ill., where construction has been started on a platforming unit of about 13,000-barrel-a-day capacity, and an alkylation unit capable of producing about

Illustration at bottom shows effect of high-velocity turbulently flowing sea water on the inlet end of an Admiralty tube. At the top you see the effect of high-velocity, turbulent flow of sea water around once-lodged pebble or shell in Admiralty tube cooled by sea water.

VELOCITY: how serious tube damage from this cause can be avoided

High velocity is a big factor in causing turbulent flow of the cooling water. This in turn may lead to rapid inlet-end corrosion of condenser tubes, particularly in plants on tide water. You can smooth out the flow of water by using deep water boxes and by flaring the inlet ends of tubes. And you should do away with water obstructions. All these help to increase tube life.

Where a tube is partially blocked by a pebble, shell or other debris, local high velocities can occur. It is highly desirable to prevent the entrance of such material into condenser tubes. But it's not always possible. If you want to avoid serious damage from this cause, inspect and clean tubes frequently.

Velocity is only one factor affecting tube life. Publication B-2, "Anaconda Tubes and Plates for Condensers and Heat Exchangers," discusses *all* the important operational factors, and gives much other useful information. And, of course, our Technical Department stands ready to assist you in the selection of tube alloys from our extensive line. *The American Brass Co., Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.*

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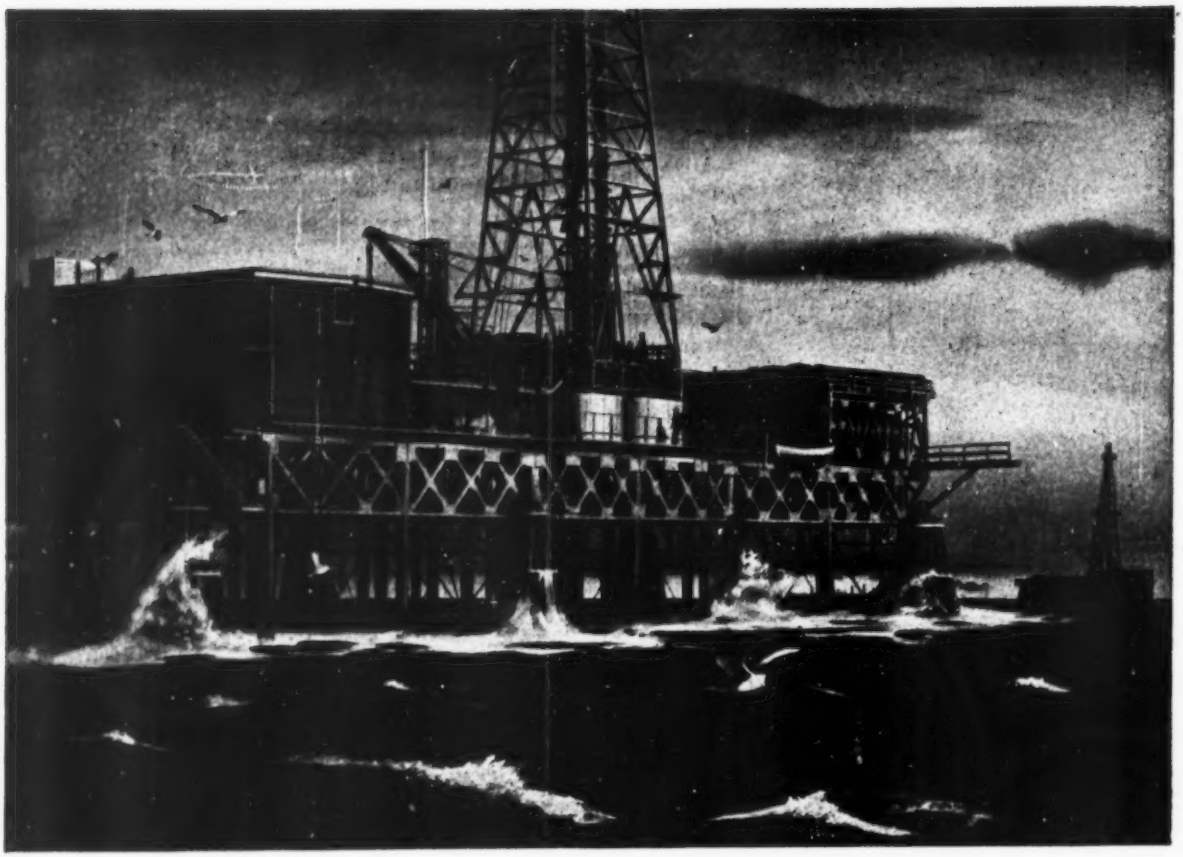
*U. S. Patent No. 2,093,695 (OHIO.)

For more data on advertised products, use Readers' Service Cards, last page.



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2250 barrels of alkylate a day.

The **West Tulsa Works,** Tulsa, where construction of a platforming unit is expected to begin in September of this year. The unit will have a capacity of about 9000 barrels a day of straight run gasoline and is to be completed in the fall of 1955.

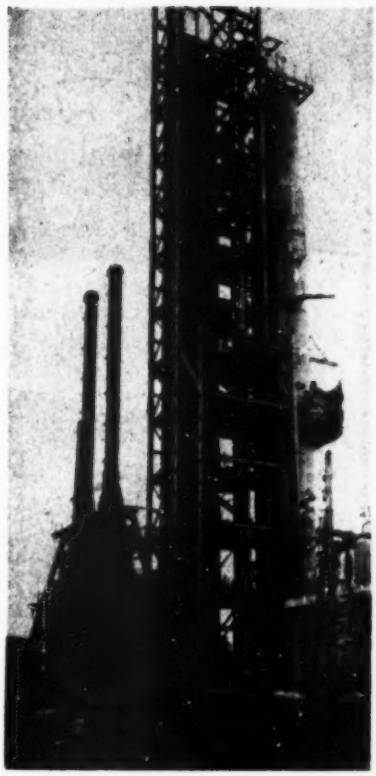
All of the plans by Texaco are in addition to the complete modernization and expansion programs now being carried out at the company's El Paso and Amarillo, Texas, refineries. These projects are scheduled for completion by early fall of this year.

Empresa Colombiana Sets Startup of New Refinery

The new Barrancabermeja, Colombia, refinery being built by Empresa Colombiana de Petroleos, the Colombian government oil company, is scheduled to go on stream next month.

The refinery is to be formally dedicated in August, following startup of a 30,000-barrel-a-day topping unit and a 15,130-barrel-a-day fluid catalytic cracking unit. Other facilities in the $30 million project are a 16,500-barrel-a-day visbreaker, 1200-barrel-a-day sulfuric acid alkylation, and offsite units.

Originally built by Tropical Oil Company in 1951, the Barrancabermaja refinery had a capacity of 27,000 barrels a day when it was taken over by the Colombian government. Foster Wheeler Corporation, which built the original refinery, has handled the modernization and expansion which will up the plants daily capacity to 37,250 barrels.



Who's Building . . .

←

Albatros Readies New Unit—

This 3600-barrel-a-day Houdriflow catalytic cracking unit at the Antwerp, Belgium, refinery of Albatros S. A. Belge pour le Raffinage de Petrole is rapidly nearing completion. The reactor-kiln and catalyst storage vessels are flanked on the left by the feed heater and in the foreground by the compressor house.

Part of Albatros' expansion and modernization program, the unit was designed and licensed by Houdry Process Corporation, Philadelphia. Head Wrightson Processes, Ltd., of London, collaborated with Houdry on engineering and procurement.

Allied Division Dedicates New Petrochemical Plant

The new petrochemical plant of Allied Chemical & Dye Corporation's Nitrogen division at Orange, Texas, has been dedicated. The new installation is the initial unit constructed by the division.

The Orange plant recently began production of ethylene oxide, ethylene glycol and diethylene glycol. It was designed by Scientific Design Company and the general contractor was Austin Company, Houston.

Lieutenant Governor Ben Ramsey of Texas was the principal speaker at the dedication.

Tide Water Considering Sites for Planned Project

Sites for the 100,000-barrel-a-day refinery Tide Water Associated Oil Company proposes to build somewhere on the Eastern Seaboard are being considered. The company is reportedly taking into consideration the government's announced desire that new plants be built outside concentrated industrial areas, where possible.

The proposed refinery, to cost $75 million, is to supplant the company's 87,500-barrel-a-day Bayonne, N. J., refinery. Because of this purpose Tide Water is not considering any site less than 750 to 1000 acres in order to have sufficient space for future expansions.

Construction Capsules

Gulf Oil Company has completed a $50 million expansion program at its Philadelphia refinery, increasing capacity by 75 percent to 183,000 barrels a day. Among the units are a 63,750-barrel-a-day fluid catalytic cracker and a 125,000-barrel-a-day atmospheric vacuum still, each largest of its kind in the world. The M. W. Kellogg Company built the cat cracker, Foster Wheeler the still.

Gulf has also started operation of a semiportable natural gasoline plant near Winters, Texas. Designed to handle 5 Mmcf of gas a day, the unit is capable of producing both natural gasoline and LPG.

Bay Refining Corporation expects to complete construction of a "packaged" Thermofor catalytic cracking unit at its Bay City, Mich., refinery in August. New facilities include a 6000-barrel-a-day cracking unit and a 300-barrel-a-day catalytic polymerization unit. The unit is being built by Southwestern Engineering Company.

Naph-Sol Refining Company, Muskegon, Mich., has awarded a contract to Southwestern Engineering Company, Los Angeles, for the erection of a 1000-barrel-a-day UOP platformer and a 2500-barrel-a-day naphtha fractionating unit. Completion of the new facilities is scheduled for next September.

Sta-Vis Oil Company plans to replace its St. Paul, Minn., plant, which was recently destroyed by fire, as soon as possible. New plant will be built on site of one destroyed if the company can get additional land; otherwise it will be erected in the Midway District of St. Paul. The company manufactures lubricants of all types, rust preventives, permanent antifreezes and other products.

The Dow Chemical Company has initiated engineering plans for a $3 million soda ash plant at Freeport, Texas, and plans to begin construction soon. The plant, designed to produce 300 tons a day of soda ash, is in addition to Dow's other current projects, a glycerine plant and a polyethylene plant at Velasco, Texas. Company plans call for completion of the glycerine unit by January, 1956, and the polyethylene unit by August, 1955. Combined construction cost: $18-20 million.

Allied Chemical & Dye Corporation's General Chemical division has begun construction to double the output of "Genetron" refrigerants and aerosol products at its Baton Rouge, La., works. The project is slated for completion early this summer.

Alabama By-Products Corporation, Birmingham, Ala., and **Hercules Powder Company** are jointly building an anhydrous ammonia plant at Birmingham. Scheduled for completion in 1955, the new plant will have a capacity of 45,000 tons a year and will be the first commercial production of ammonia in that area.

Spencer Chemical Company has authorized a $1,750,000 expansion of its Henderson Works in Henderson, Ky. The project will add new nitric acid facilities and a Spensol plant, which will be moved from Charleston, Ind., where Spencer formerly operated a plant.

Jefferson Chemical Company plans a 50 percent expansion of its ethanolamines production facilities at Port Neches, Texas, with much of the increased production to go into the manufacture of morpholine.

Continental Blacks, Inc., has started operation of its 40-million-pound-a-year carbon black plant at Ponca City, Okla. The output will be marketed by Witco Chemical Company.

Tennessee Production Company has opened a new extraction plant at Banquette, Texas. The plant processes 120

Badger

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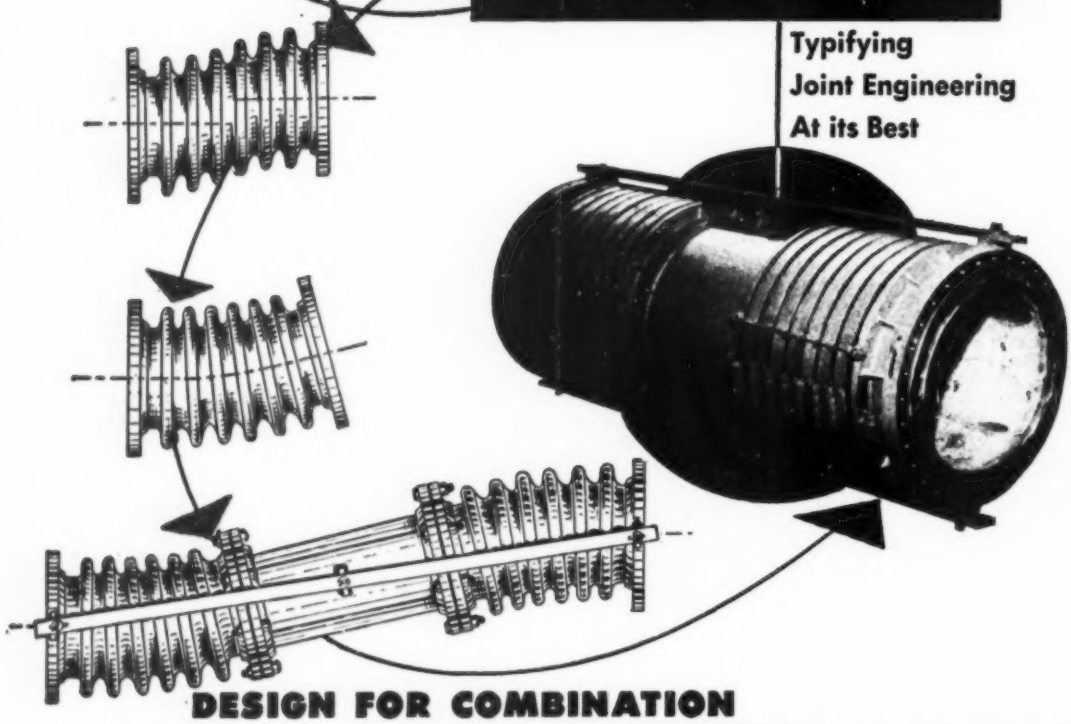

DESIGN FOR COMBINATION LINEAR-SHEAR-LATERAL MOVEMENTS

Study these sketches showing (somewhat exaggerated, of course) several of the more complex movements to which expansion joints are often subjected. Do you have such pipe line conditions? Do you have any installation coming up that might involve such movements?

Here's the Badger Joint that is designed for just such a problem: the TANDEM JOINT. It's available in both Self-Equalizing and Non-Equalizing design. The joint movement is controlled by the tandem bars pivoting on a pin in the connecting nipple. Permissible shear or lateral movement depends upon the overall length as well as the number of corrugations in each unit. Each tandem unit is designed to suit the individual job requirements.

The Tandem Joint is but one of several special types designed for complex pipe line movements. We'll be glad to study your problem and make recommendations. Should yours be a straight linear traverse—as most installations are—we have a wide range in Directed Flexing, Self-Equalizing and Non-Equalizing Joints made of copper or stainless steel, with flanged or welding ends.

Badger Expansion Joints come in a variety of types and a wide range of sizes: Directed Flexing, Self-Equalizing for longer traverses and higher pressure; Non-Equalizing, for shorter traverse or when pressures are low. Tandem Joints for combination axial and lateral movements; Clevis Joints for angular rotation.

Special Vibration Control Joints; Flexible Pipe Line Seals for watertight connection between pipe and flood walls.

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Original and Sole Manufacturer of Badger Expansion Joints

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Mmcf of natural gas a day.

Blaw-Knox Company has begun construction of a natural gas compressor plant near Sterling, Colo., to serve the Mount Hope and Walker fields. To have a capacity of 4.5 Mmcf of gas a day from field pressure of 5 psi to 800 psi, the plant is being built jointly by Paul E. Barnhart, J. Ray McDermott & Company, Inc., Kansas-Nebraska Natural Gas Company, Inc., The Texas Company, Bay Petroleum Corporation, and Shell Oil Company.

Ashland Oil & Refining Company has concluded licensing arrangements with Houdry Process Corporation for a 6000-barrel-a-day Houdriformer to be constructed at Ashland's Catlettsburg, Ky., refinery.

Richards Oil Company is considering construction of a $500,000 to $750,000 refinery on a 132-acre site it recently acquired at Savage, Minn.

Imperial Oil, Ltd., has officially opened new process units at its reconstructed Regina, Saskatchewan, refinery. Capacity of the plant has been increased from 20,000 to 22,500 barrels a day. Largest of the new units is a 7500-barrel-a-day fluid catalytic cracking unit. Other new units: treating plants, a vacuum distillation unit, a technical building and mechanical shops.

S. A. Concessionaria de Refinacao de Petroleos em Portugal (SACOR) has started up a new 10,000-barrel-a-day TCC unit at its refinery near Lisbon, Portugal.

Egyptian Ministry of Commerce and Industry has indicated that the capacity of the government-owned refinery at Suez will be expanded to produce more than double the present output. The Ministry has asked the country's Ministry of Finance to approve a credit of $25 million for importation of equipment needed to do the job. Long-range aim for the refinery is a capacity of about 25,000 barrels a day.

The Iraq government has begun preliminary site work on its new 24,000-barrel-a-day refinery at Dora, near Bagdad. The M. W. Kellogg Company is building the plant, which is expected to be completed in the middle of 1955.

Standard Oil Company (New Jersey) has signed a contract with the West Bengal (India) government to build a refinery in that area if drilling operations soon to get under way there are successful.

Vacuum Oil Company has begun additions to its Altona, Victoria, Australia, refinery for production of high-octane fuel. The refinery is expected to begin producing about 20 million gallons a year by 1956.

The Ohio Oil Company is to start construction this month of a natural gasoline plant in the West Sidney field of Cheyenne County, Nebr., and expects completion within three months. To have eventually a capacity of 12 Mmcf of gas a day, the plant is expected to start with 7.5 Mmcf a day.

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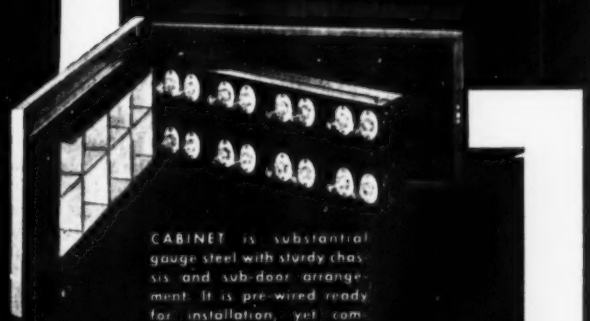
PANALARM "50" PLUG-IN UNIT hermetically sealed and most versatile ever developed simply plugs into chassis to expand system no wiring no other connections. Corrosion-proof and suitable for Class 1, Div. 2 locations.

Built-in flexibility of PANALARM "50" allows simple change-over to any operating sequence as required by present or future conditions. And, at the same time PANALARM "50" introduces a new instrument-type annunciator construction adding to the long-term dependability of the entire system.



CABINET is substantial gauge steel with sturdy chassis and sub-door arrangement. It is pre-wired ready for installation, yet completely flexible without re-wiring.

PANALARM ANNUNCIATOR SYSTEMS are self-contained with either illuminated name-plates or bullseye visual signals. Both the audible signal and acknowledgment button are common to the entire system.

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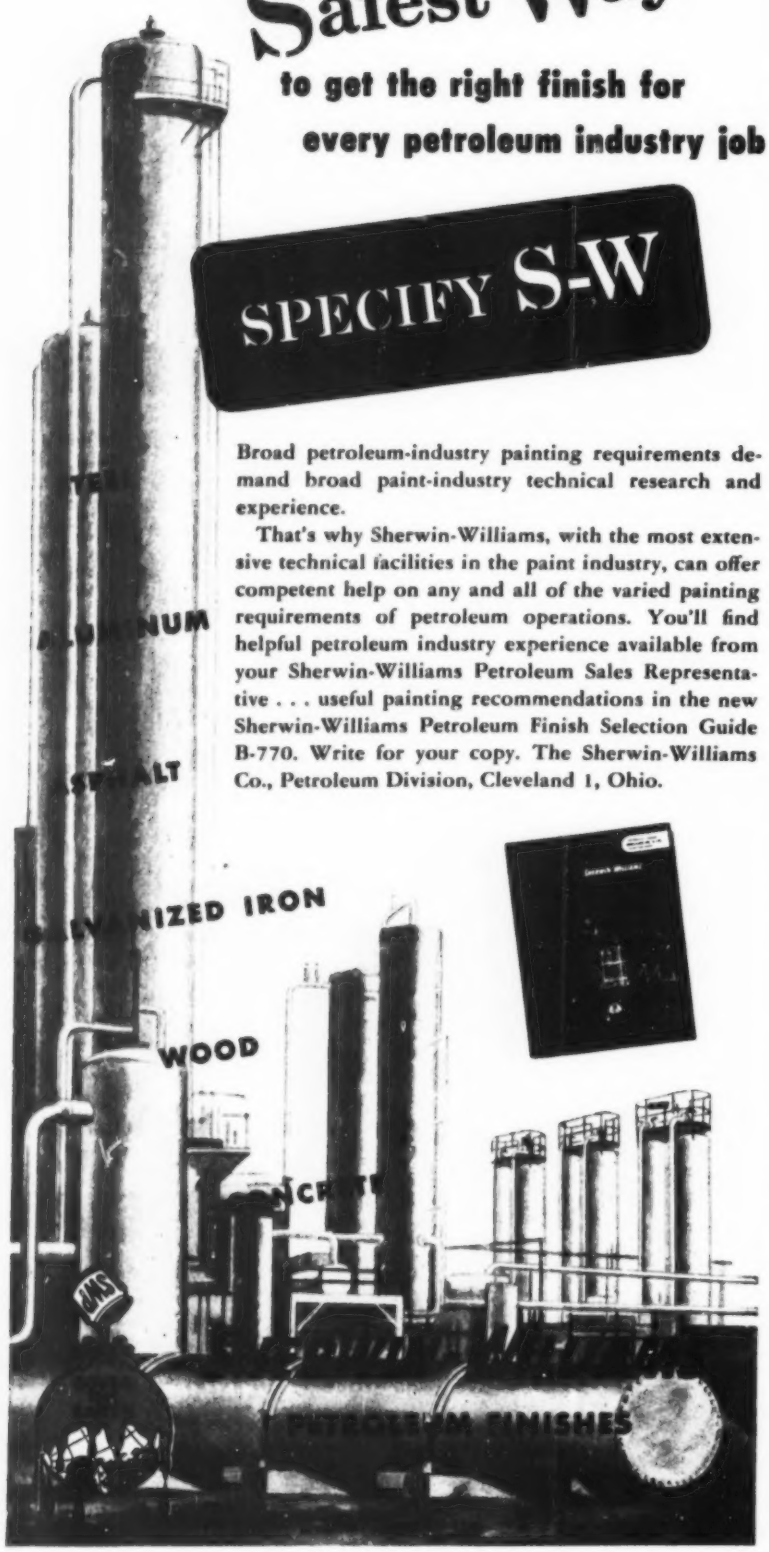

Who's Building . . .

Canadian Petrofina Will Build Ultraforming Unit

Canadian Petrofina has been licensed to use the Ultraforming process of Standard Oil Company (Indiana). Canadian Petrofina's Ultraformer will have a capacity of 3600 barrels a day and will be included in the 20,000-barrel-a-day refinery being built at Point aux Trembles, Montreal, Canada.

Engineering has been completed on the unit, which is scheduled to go on stream in the second half of 1955. The M. W. Kellogg Company is to build it and American Cyanamid Company will probably supply the platinum catalyst used in the process to reform low-octane gasoline to high-octane gasoline.

Other units in the project include the following: 20,000-barrel-a-day topping unit with a vacuum flashing capacity of about 10,000 barrels a day; a 4000-barrel-a-day visbreaker; catalytic polymerization and alkylation units with feed desulfurization facilities, 2500-barrel-a-day distillate treater and a 6500-barrel-a-day gasoline treater. The refinery is expected to cost $20 million.

AIOC to Have Big Jump In Refining Capacity

By 1955 Anglo-Iranian Oil Company will have more than offset the refining capacity lost as a result of the shutdown in 1951 of its Abadan refinery.

With the completion of two new refineries, together with expected increases in existing facilities, Anglo-Iranian's total refining capacity by the end of 1955 should be in the neighborhood of 609,300 barrels a day.

In a statement to the company's shareholders, Sir William Fraser, board chairman, said Anglo-Iranian total refining thruput was increased in 1953 by 40,600 barrels per day last year to 406,200 barrels a day.

But the big increases are yet to come. A 120,000-barrel-a-day refinery at Aden on the Red Sea is scheduled to go on stream this summer, while a 60,000-barrel-a-day refinery at Kwinana, Australia, will start operations early in 1955. The company's Continental refineries will also add to the over-all total. Capacity of the 36,300-barrel-a-day Antwerp, Belgium, refinery, jointly owned with Petrofina Company (which was upped only last year from 34,900 barrels a day) will be increased to 54,800 barrels a day during the next 12 months. Capacity of the Hamburg, Germany, refinery, at 14,300 barrels a day last year compared to 13,500 barrels a day the year before, will be boosted to 25,400 barrels a day during 1954.

Intercol Will Build New Cartagena Refinery

Investment of $20 to $25 million in a new refinery at Cartagena, Colombia, is planned by International Petroleum (Colombia), Ltd. Construction of the Intercol refinery, to be located on the Caribbean coast, is scheduled to begin early in 1955.

Construction of the refinery has been

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Airetool small tube cleaners are designed to make it easier to thoroughly remove hard or soft foreign deposits of any type from condensers, heat exchangers, or other small diameter tubular equipment; quickly and with maximum safety to inside tube surfaces.

Used with either flexible drive or a universal joint, and powered by husky air-driven Airetool motors, these small cleaner heads quickly remove foreign deposits from straight or bent tubes of ⅝" to 2" I.D.

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There's An Airetool Tube Cleaner and Tube Expander for Every Type of Tubular Construction.

Who's Building . . .

under discussion for some time, with the Colombian government indicating it was prepared to start construction if private investment could not be found to finance the project.

Construction of another refinery is reportedly planned for Colombia's Cali area before 1963. The builders of this plant have not been disclosed.

Llano Grande Building $5 Million Gasoline Unit

Construction has begun on a gasoline plant in Cochran County, Texas, for Llano Grande Corporation of Houston. Located about five and one-half miles south of Lehman, the plant is designed to process 25 Mmcf of gas a day and will cost approximately $5 million.

Contract for the design and construction of the plant and gathering system has been awarded to Tellepsen Petro-Chem Constructors, a division of Tellespen Construction Company of Houston. The contract calls for completion of all facilities by the end of this year.

Salt Lake Refining Will Add Second Cat Cracker

Immediate construction of a second catalytic cracking unit at Salt Lake City, Utah, is planned by Standard Oil Company of California. Designed for a capacity of 8000 barrels a day, the new $2.5 million plant will be an addition to facilities at Salt Lake Refining Company, a subsidiary of California Standard.

Contract for construction of the new cat cracker has been awarded to The Fluor Corporation, Ltd., Los Angeles. Construction will begin within the next several weeks, with completion scheduled for April, 1955.

Chinese Petroleum Lets Contract for Taiwan Unit

The Fluor Corporation, Ltd., Los Angeles, has been contracted for the engineering, equipment procurement and construction supervision of a Socony Type-45 thermofor catalytic cracking unit for Chinese Petroleum Corporation at its Kaohsiung, Taiwan (Formosa), refinery.

Charge stock to the unit, to include a feed preparation and gas recovery system, will be 10,000 barrels a day, from which 6500 barrels a day of distillate will be charged to the cat cracker reactor.

Fluor is to begin engineering work immediately, with completion scheduled during the first half of 1955. Kaohsiung is located on the southwest coast of Taiwan.

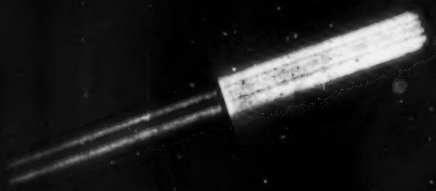
California Standard Lets Cat Reformers Contract

Contract for design and construction of twin catalytic reforming plants at Standard Oil Company of California's Richmond and El Segundo, Calif., refineries has been awarded to Bechtel Corporation.

The two projects, scheduled to get

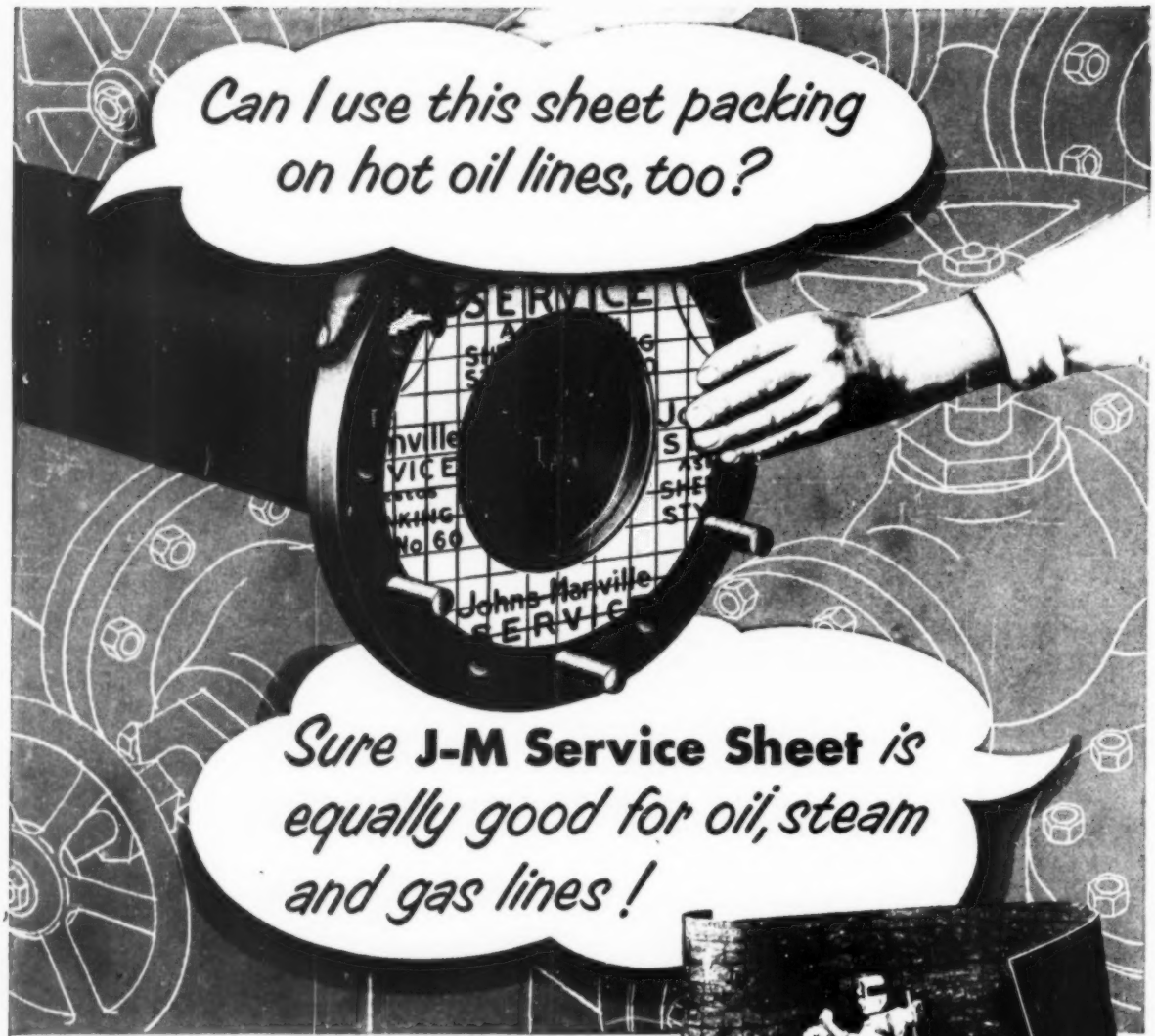
NOW

You See It



This is part of a spectrograph made during laboratory tests of crude oil before and after electrical desalting in Howe-Baker equipment. Notice the bright sodium line in untreated right strip as compared to the greatly reduced intensity of sodium line on the left after treating. Spectacular results like this are some of the reasons why refiners on three continents are desalting more than one million barrels of crude oil daily in Howe-Baker installations.

HOWE-BAKER CORPORATION
ESPERSON BUILDING HOUSTON, TEXAS


Can I use this sheet packing on hot oil lines, too?
Johns-Manville
Sure J-M Service Sheet is equally good for oil, steam and gas lines!

Your J-M Packings Distributor can tell you why this quality sheet packing has maintained such an excellent reputation for over 35 years

Where it's used: Every industrial plant can use J-M Service Sheet Packing to advantage. It's the favorite packing of thousands of plant engineers and maintenance men. Both versatile and dependable, Service Sheet makes a tight, long-lasting seal against superheated steam, air, gas, water, hot oil and ammonia, as well as many acids and chemicals.

What its advantages are: J-M Service Sheet is a quality packing, made of selected long-fibre asbestos bonded with heat-resisting compounds. It is graphited on one side to permit breaking a joint without destroying the gasket. The ungraphited side is ruled into one-inch squares to speed cutting and reduce waste. And . . . you can order it in large economical quantities because J-M Service Sheet will not dry out in stock!

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Your J-M Packings Distributor carries complete stocks of J-M Service Sheet and other quality Johns-Manville Packings. He can help you choose the right packing for your application. Write him for complete information and copy of folder PK-19A, "Thousands of Plants Rate It Tops." Or address Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay Street, Toronto 1, Ontario.

JM PRODUCTS

Johns-Manville PACKINGS & GASKETS

Who's Building...

under way immediately, comprise the nucleus of a $30 million refinery program designed to increase the quality and octane ratings of Standard's motor gasolines. Both plants are expected to be ready for operation by the spring of 1955.

Benzin-und Petroleum Ups Hamburg Refining Thruput

A major increase in the capacity of the Hamburg, Germany, refinery of B. P. Benzin-und Petroleum, G.m.b.H., has been effected with the commissioning of a new combined atmospheric and vacuum distillation unit.

The new Foster Wheeler combination unit provides 12,000 barrels a day in atmospheric distillation and 7000 barrels a day in vacuum distillation. A platforming unit, first of its kind in continental Europe, is scheduled for completion at the plant early in 1955.

A continuous asphalt blowing plant and filling and mixing facilities for production of 50,000 tons of asphalt annually are also under construction.

Another 2500 barrels in thermal cracking capacity will be added to the plant's now 5500 barrels a day early next year.

Capacity of the Hamburg plant, operated by the German affiliate of Anglo-Iranian Oil Company, Inc., is now 24,800 barrels a day. This capacity coupled with the 4000 barrels a day of the company's nearby Schindler refinery raises the German refining capacity of Anglo-Iranian to 28,000 barrels a day.

Lion Starts Shipments Of Anhydrous Ammonia

Shipments of anhydrous ammonia have started from the Barton plant of Lion Oil Company, which is near New Orleans, La. The plant, under construction since the middle of 1952, is expected to be in full operation this month.

Current production of anhydrous ammonia runs up to the designed capacity of approximately 300 tons a day. When all facilities of the Barton plant are in full production, it is expected that shipments of anhydrous ammonia and pelleted ammonium nitrate will average about 600 tons per day. By-product carbon dioxide will be utilized for the production of about 42 tons daily of dry ice and liquid carbon dioxide.

Nitric acid, an intermediate chemical in ammonium nitrate manufacture, will be produced in a unit with capacity of 430 tons of acid a day.

Monsanto Division Upping Lube Additives Capacity

Construction of facilities to increase production of detergent additives for lubricating oils has started at the W. G. Krummrich plant, Monsanto, Ill., of Monsanto Chemical Company's Organic Chemicals division.

The added capacity, which will approximately double the company's production of detergent-dispersant oil additives, is expected to be in operation by September of this year.

A Controlled Fire Hazard
CATALYTIC CRACKING UNITS
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PUMPING STATIONS
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Count 'em — seven propane storage tanks — a potential disaster area for most petroleum properties. Not so at this large refinery though. "Automatic" FIRE-FOG is ready at all times to detect and extinguish the smallest blaze before it becomes a large one — before it shuts down operations, damages equipment, reduces profits.
Many installations of ENGINEERED "Automatic" FIRE PROTECTION have been made in refinery and petro chemical properties throughout the Western Hemisphere and the record speaks for itself: "Complete control of fire within protected areas — in seconds!"
If you're the one responsible for plant safety and continuity of production, we'd suggest an early review of your fire hazard safeguards. Then, whether your needs call for protection by means of "Automatic" Sprinklers, water spray, chemical or mechanical foam, carbon dioxide, or dry powder, we'll gladly provide, at no cost to you, preliminary engineering service. Through this you'll be able to evaluate the economic and adaptability features of each method of protection for your own risk.
Write or call us today for an appointment with a "Safety First" future.
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There's more to instrumentation than instruments

Instruments can do wonders, if they're given the chance. But some one has to put them to work in the most effective way. And that's where Honeywell Application Engineering steps in.

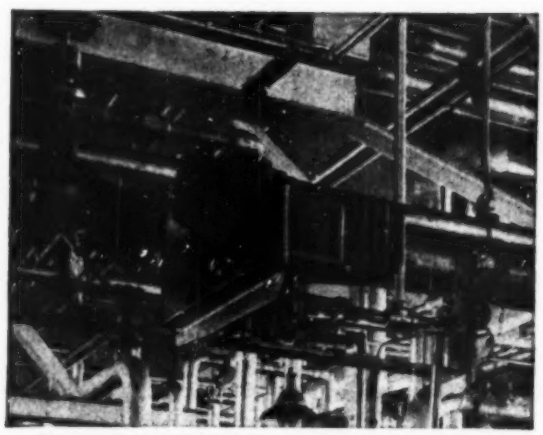
This service is one of the most important plus values you get in Honeywell instrumentation. It's a teamwork job. And every member of the team is an expert in his own field. Engineering begins right in your own plant, where a Honeywell field man digs out the vital facts about your process. He sits down with your engineers, production men and instrument technicians . . . and finds out everything he needs to know about what needs to be measured or controlled, to what accuracy, and under what conditions.

Then the problem goes to Honeywell's Application Engineering staff. Here's where you'll find groups of instrumentation specialists for every major industry. One group, for example, is devoted to the control problems of the metal-working industry. Another handles ceramic applications . . . another chemical . . . until together they cover the whole gamut of modern processes. These men know their specific field from years of first-hand experience. They're thoroughly familiar with the techniques of processing and the ways that instrumentation should be applied.

Honeywell Application Engineers develop detailed recommendations for the complete installation. They determine the most effective instruments, primary elements, types of control and valves for every phase of measurement and control. They add switches, signals, interlocks and other accessories which their experience indicates are needed in the interest of safety and convenience. Then they combine all components into a complete system—whether it involves a single instrument or a whole panel—that is designed for peak production efficiency, simple maintenance, and greatest convenience to operators.

This service saves time by doing engineering work that would tie up your own staff for many hours. And it pays off in assuring the excellent performance of which Honeywell instruments are capable.

Complete Honeywell instrumentation *covers every need*



Differential Converter mounted on pipe transmits flow data to a remote recorder on the central control panel.

Honeywell instrument control panel for repressuring plant operated by Stanolind Oil & Gas Company at Elk Basin, Wyoming.

of field processing plants

PLANNING a field processing plant? You don't need to "shop around" for instrumentation for the specialized applications of this kind of unit . . . because the broad line of Honeywell instruments encompasses practically every measuring and controlling assignment. Of particular interest to gasoline plants are:

ElectroniK indicators, recorders and controllers . . . the standard of precision and dependability, these instruments can measure dozens of different variables. The selection includes circular chart and strip chart models, and the Precision Indicator for rapid checking of up to 48 separate temperature points.

Brown Thermometers and Pressure Gages . . . available in practically unlimited choice of ranges and with various forms of pneumatic control.

Flow Meters . . . evenly graduated type for accounting and square root scale type for control applications. Electronic integrator gives fast, accurate flow totalizing. Choice of electric and mechanical meter bodies.

Differential Converter . . . a rugged but sensitive pneumatic balance transmitter for remote measurements of flow, and differential pressure.

Working with these instruments is a full selection of primary elements, control valves and accessories . . . from which Honeywell specialists design custom-fitted systems for individual process requirements. And behind these products stands a nationwide service organization that is always ready to help you, wherever and whenever you need instrument service.

Your nearby Honeywell sales engineer will be glad to discuss your own process control application . . . and he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

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Workers provide some of their own music at the weekly Bible lessons conducted by Chaplain-Counselor Charlie Martin in the refinery of the Mid-Continent Petroleum Corp., Tulsa. Right to left, the men in the quintet are Grady William Cunningham, Tony Clifton Fox, Rufus Aguilar, Ernest W. Spurgeon and Opla Elbert Ragsdale.

Counselor Service Program Helps Workers Do Better Job

'Plain Charlie' shows Mid-Continent Petroleum employes how to live at peace with themselves, their families and management.

John S. Sparks, Jr.,
Tulsa

MID-CONTINENT Petroleum Corporation has proved that religious counseling promotes contentment and creates harmony in employe-management relations.

For a number of years the company has had a full-time chaplain-counselor at the Tulsa refinery. The "Reverend," besides being an ordained minister, is also a skilled worker. His job is to provide spiritual and moral support to workers who need it and who call for it. He also conducts lunch-hour Bible class or prayer meetings consisting of prayers, hymns and a brief sermon.

Rev. Charles Martin—he prefers to be known as plain Charlie—is the chaplain-counselor who "sold" the idea to his company after seeing it work in other industries.

Most impressive part of the program is the lunch-hour religious services to which all workers are invited, Catholic, Protestant and Jew.

When the noon whistle blows the men at the refinery go to the carpenter shop, which is centrally located. Inside are rows of chairs, a small pulpit with a "mike" and amplifier, a record player, and records of hymns and other religious songs.

Everything is informal. There is no collection. The men are there for a message which they expect will lighten and make their toil more pleasant through a better understanding of how to cooperate with their fellow-workers and management.

Chaplain Martin's assistant, Counselor Herbert Miller, plays a record and Martin then steps to the pulpit.

Thus starts the weekly Bible classes.

Membership comprises men of all ages from the young to the oldest.

As the men listen to Martin's teaching there is no atmosphere of false piety. There is no roll call. Management doesn't know who attends or who does not. There are no bonuses for attending and no demerits for non-attendance. The classes belong to the men.

The men listen intently as Chaplain Martin makes his non-denominational talk. His lessons go deeper than just the application of the Golden Rule to the day-by-day life of the men. They want to know how to use Christianity as a balance for their daily lives.

Martin gives the men Christianity as a foundation for both home and work. He gives them faith in a Supreme Power as an ever-present guide and help.

There is no planned ceremonial. Usually, there is music. Many of the workers are musicians. A quartet or a quintet often provides the music. Lack

DEKORON PRODUCTS CUT INSTRUMENT TUBING COSTS

EASY-TO-INSTALL INSTRUMENT LINE HARNESS

DEKORON Poly-Cor is a new concept in instrument tubing — a lightweight instrument line harness that can be strung as easily as electric wiring.

Poly-Cor is composed of color-coded polyethylene tubes over which is extruded a thick vinyl sheath. This construction means instrument lines are completely corrosion proof. Their natural resiliency resists physical damage. Harness composed of 4, 7, 10, 14 or 19 (*illustrated*) individual lines is available.

Initial cost . . . installation . . . corrosion resistance . . . maintenance — *no tubing can compare with patented Dekoron Poly-Cor.* Request Bulletin L-6506.

Use Dekoron E-Z Tube Fittings. Specifically designed for use with Poly-Cor or with single-line plastic Dekoron "P" Tubing.

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quality research service

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DEKORON PRODUCTS DIVISION

As Management Sees It . . .

of formal training is offset by sincerity.

The talks last about a half-hour. Fifteen minutes before time for the return-to-work whistle, the foremen and supervisors, who usually sit close to the door, leave the meeting to prepare for the men to return to their duties.

The sermon is closed 5 to 10 minutes before time for the whistle to allow the men time to get back to work.

The men who attend the Wednesday noon meetings are mechanical shop workers. Thursday noon a similar meeting is held for employes of the car shop.

Average attendance at the Wednesday talks is 60. At times it has reached 100. In the car shops, with a much smaller number of employes from which to draw, the average attendance is 16 to 20.

Idea is Born—Martin came into contact with the idea while working with the Victory Service Centers established in principal cities during the war. He decided to give it a test and with some of his co-workers, made a factory-to-factory canvass. At some plants they found an open door; at others, the door was closed.

Martin held just enough meetings during this period to get an idea of the wide field that existed for this type of service.

In December, 1945, he returned to his former work in charge of shift, in the gas plant of the Mid-Continent refinery. He had made up his mind this was the sort of service he wanted to make his life's work. In June, 1946, he took a leave of absence to attend a summer seminar at the Wheaton School in Chicago which dealt with industrial religion.

In 1947, Martin entered safety work for Mid-Continent. This widened his acquaintance among the workers.

Martin had approached the company with his idea for a counselor service shortly after his return at the end of 1945 from his service center work.

The idea needed time to germinate. It was a big step for a company to be "first" in a project of this type. That such a program must succeed was important. It could cause dissatisfaction instead of serving to better employe relationship if it failed.

Months passed without any decisive action on the part of the company.

Meanwhile, Martin would drop in at places where men were eating during the noon hour as part of his safety work, particularly in the car shops. Many knew he was an ordained

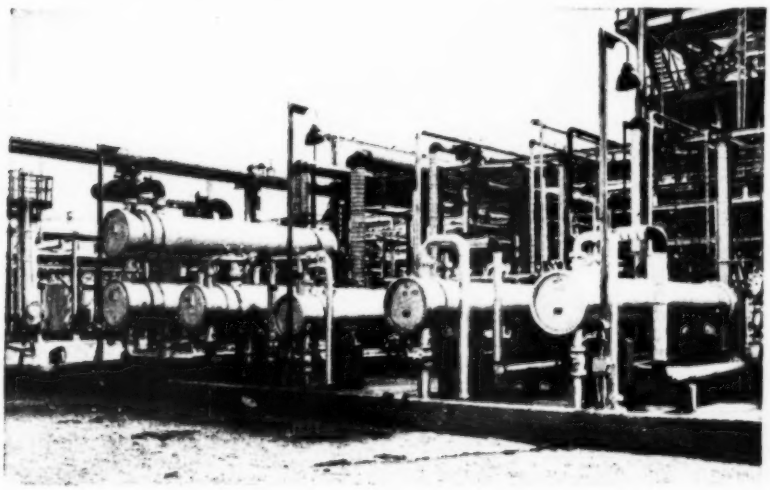
For more data on advertised products, use Readers' Service Cards, last page.

BRIDGEPORT BRASS COMPANY

CONDENSER AND HEAT EXCHANGER TUBE EDITION

COPPER ALLOY BULLETIN

Bridgeport Brass Co. MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND. — IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL



Choice of Tube Alloys Vital to Economical Heat Exchanger Operations

Heat exchange plays two roles in refinery or process operations. It is an important factor in the technical success of the operation, and, by utilizing excess heat in a cycle, it plays a vital role in that operation's margin of profit. Technically and economically, then, the backbone of profitable heat exchange is selecting the correct alloy for every operating condition.

In petroleum refining and petrochemical processing, the hydrocarbons themselves are virtually noncorrosive to copper and its alloys. But the presence in hydrocarbons of sulfides, chlorides, various acids and bases, solvents, ammonia, carbon dioxide and other gases, and moisture, over a wide range of temperatures, velocities and pressures do cause corrosion.

Adding to the problem, heat exchanger and condenser tubes must withstand the corrosive action of many types of cooling water. The choice of proper metals or combinations of metals is therefore most important.

Hydrogen Sulfide

The most common corrosive materials met in petroleum refining and petrochemical processing are hydrogen sulfide and mercaptans, etc. Long experience has proved that the higher zinc alloys such as Bridgeport Arsenical Admiralty, Arsenical Aluminum Brass and Arsenical Muntz resist sulfur corrosion better than Copper, Red Brass, Duronze IV (Arsenical Aluminum Bronze) and 90-10 Cupro Nickel.

Bridgeport uninhibited Admiralty and Aluminum Brass have given service where desalting, acid neutralization and other processing methods have cut corrosiveness on the product side. While in some cases such treatment allows use of Bridgeport 70-30 Cupro Nickel and Duronze IV, neither of which are highly resistant to sulfur attack but both of which offer distinct advantages toward the water side.

Alloys for Cooling Water

Cooling waters vary considerably from plant to plant. Refineries using sea water or brackish water have the most severe corrosion problems. Where sea water velocities do not exceed five or six feet per second, and debris is absent, Bridgeport Arsenical Admiralty or Arsenical Muntz is usually an economical choice. Sea water velocities above six feet per second are best handled by Bridgeport Arsenical Aluminum Brass, Duronze IV and 70-30 Cupro Nickel.

Bridgeport 80-20 and 90-10 Cupro Nickel can sometimes be profitably used in place of 70-30 Cupro Nickel to handle sea water. Bridgeport 90-10 Cupro Nickel containing 1.0% iron as a corrosion inhibitor, while resistant to circulating sea water, is not as satisfactory as 70-30 Cupro Nickel, Admiralty or Aluminum Brass to products containing sulfides.

All of these alloys show generally excellent resistance to corrosion from fresh waters and many forms of pollution.

Solve Many Problems

Heat exchanger and condenser tubes are often attacked simultaneously inside and outside by two entirely different types of corrosive media. The answer to this problem is Bridgeport Duplex Tubes.

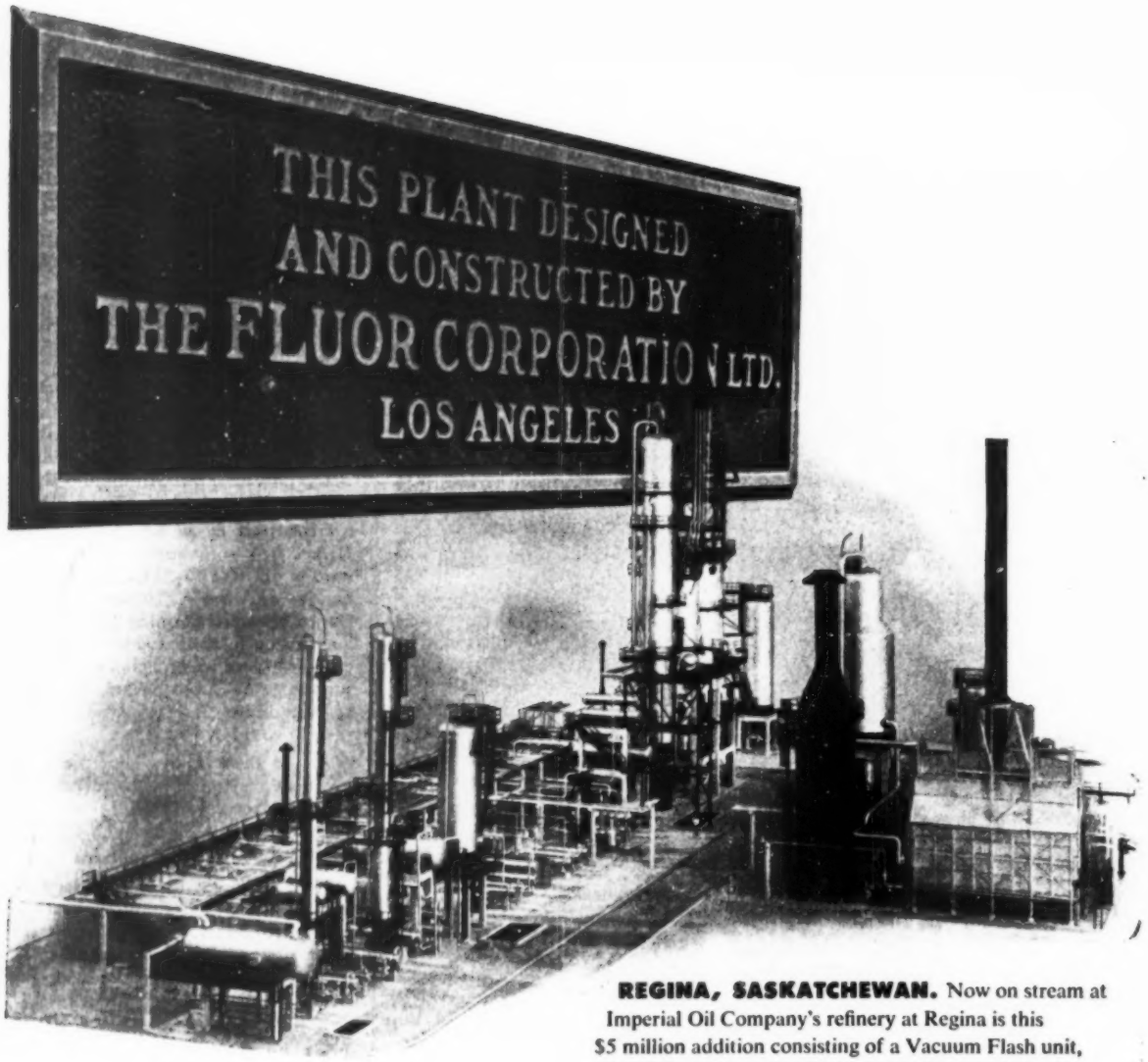
A refinery tried both steel and red brass tubes in an exchange between ammonia and hydrogen sulfide bearing propane gas and river water. The steel tubes failed on the water side every year or two, while the red brass tubes failed on the product side. Bridgeport Duplex Tubes—with low carbon steel to the product and red brass to the water side—gave an average life in this installation from 6 to 10 years.

This is just one of hundreds of cases where Bridgeport Duplex Tubes have solved difficult corrosion problems for long periods at low cost.

To Help You Select The Right Alloy

Whatever your corrosion problems on heat exchangers and condensers may be, Bridgeport Technical Service will be glad to help you in selecting the correct alloy for long service and profitable operation. Call your local Bridgeport Sales Office for technical advice on your tube problems and prompt service on your requirements.

(1924)



REGINA, SASKATCHEWAN. Now on stream at Imperial Oil Company's refinery at Regina is this $5 million addition consisting of a Vacuum Flash unit, a 13,600 barrels per day Fluid Catalytic Cracking unit (Model IV) and gas recovery systems – designed, engineered and constructed by Fluor of Canada, a subsidiary of The Fluor Corporation, Ltd. The plant, engineered for extreme variances in weather conditions, was completed on schedule and converts reduced crude oil to high quality gasoline and heating oils.

With offices in principal cities on four continents, Fluor is one of the world's major engineering and construction organizations for the petroleum, natural gas, chemical, power and allied industries.

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Chaplain-Counselor Charlie Martin of the Mid-Continent Petroleum Corporation, Tulsa. His weekly "Bible class" at the company's refinery, as well as his help and counsel on and off the job, helps maintain a better understanding between company employes and management.

minister and as a result the talks began to switch from safety to religion. They became question and answer forums. They started with two or three men.

As news of the meetings spread, the group increased to 10 to 12 men daily. There wasn't room for any more. The men then asked Martin to conduct regular Bible lessons during the noon hour.

Martin now felt he had something solid with which to go to management and ask for installation of the counselor service. The new service was inaugurated in May, 1948.

In January, 1952, the company announced the chaplain-counselor service with Martin as chaplain. At the same time Herbert Miller was named assistant counselor to serve the program.

The combination of the counseling-religious program has proved particularly effective at the Mid-Continent plant.

Like a compass, it has reached out in all directions. It has brought a closer understanding between worker and employer; man and his homelife; the citizen and his neighbors, and fellow worker with fellow worker.

Credit comes from applying the Christian principle in solving these problems. Credit lies in proving to the men that Christianity can be employed in everyday work problems.

As a man understands Christianity,

For Easiest Pipe Work ...it's the New 20 RIDGID

8 sizes for pipe from ⅛" to 6"

More utility for your money in RIDGID Bench Vises

• No wonder this bench yoke vise is popular everywhere! You can make the yoke open for either right or left hand. It has an integral pipe rest for easier cutting or threading . . . built-in pipe bender . . . strong special malleable yoke and base . . . LonGrip jaws of top quality tool-steel. You simply can't beat it for efficient easy operation that lasts for years! Buy it at your Supply House.

RIDGID Chain Bench Vise, ⅛" to 8"

Same work-saver features in RIDGID post, kit and stand yoke vises and bench, post and stand chain vises.

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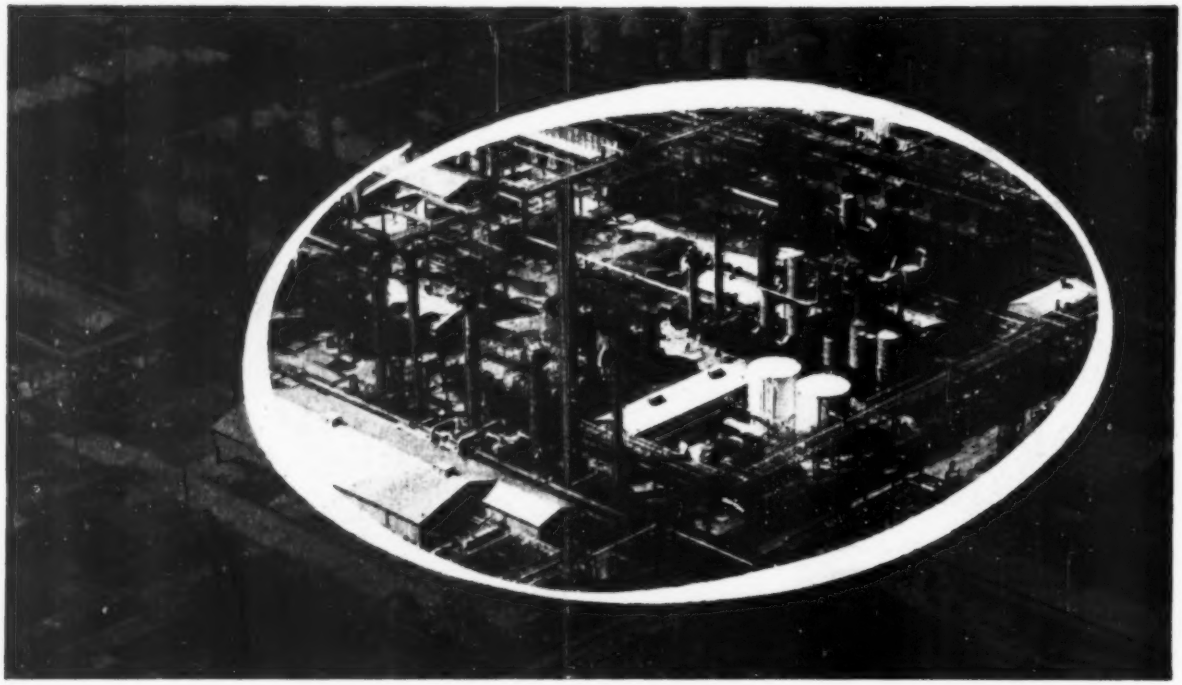
RIDGID Work-Saver Pipe Tools

For more data on advertised products, use Readers' Service Cards, last page.



In this circle purity is an absolute must

...so is Nickel— and here's why

You are looking at a section of Shell Chemical Corporation's Deer Park, Texas, plant.

There, Shell synthesizes glycerine from propylene, with allyl chloride as an intermediate. There, too, the glycerine is evaporated, purified of salt, steam-stripped, distilled and stored.

All this means corrosion and purity problems. Chlorine and propylene are reacted at a temperature which greatly accelerates corrosive attack . . . salt is present in the crude product . . . and there are strict limits on the heavy metals content of glycerine.

Yet Shell successfully combats corrosion to turn out a colorless, odorless product that assays better than 99% glycerol and meets all the usual specification requirements.

How does Shell do it?

With Inconel; in mixing jets for reacting propylene and chlorine at about 950°F. Inconel combines resistance to both heat and corrosion.

With Nickel-Clad Steel; in evaporators, distillation columns, storage tanks . . . wherever glycerine is concentrated. Nickel-Clad Steel combines the protection of Nickel with the economy of steel.

With Monel; in continuous centrifugal filter equipment used to remove sodium chloride by-product. Monel gives high corrosion-resistance and high strength in a single metal.

With pure Nickel; in bubble caps and trays; reboiler and condenser tubes, pumps, and piping. Nickel keeps metal pick-up at a minimum in hard-to-maintain areas.

The correct application of Nickel and Nickel alloys in the production or handling of glycerine can do much to lower costs and improve the quality of the product. Inco's Corrosion Engineering Section will be glad to work with you in solving specific problems connected with purity or corrosion in your own plant. Just write:

THE INTERNATIONAL NICKEL CO., INC.
67 Wall Street **New York 5, N. Y.**

Inco Nickel Alloys

Monel® • "R"® Monel • "K"® Monel • "KR"® Monel
"S"® Monel • Inconel® • Inconel "X"®
Inconel "W"® • Incoloy® • Nimonic® Alloys
Nickel • Low Carbon Nickel • Duranickel®

For more data on advertised products, use Readers' Service Cards, last page.

it leads to a better understanding of all those with whom the man associates, the program has shown.

These men all are mechanics in a sense. They understand what precision machining means. They know what machine tolerances are.

In dealing with management, neighbors, family and fellow workers they learn that man is in some respect like a machine. Some are precision-machined—some have lots of "tolerance."

Application of Christian principles, such as taught by Martin, enables the men to make allowances in their dealings for differences of way of life, education and mental ability.

Prayer has come to mean more than asking for help—it becomes a request for the ability to apply Christian principles in solving the worker's problems.

Martin has spent 29 years with the Mid-Continent. He knows and understands the problems of plant workers. He has lived among them and with them.

Hears All Problems—The counseling service has broadened to where all types of problems of plant employes are brought to Martin for aid in solving.

It isn't any eight-hour shift. It is 24 hours, seven days a week.

Grievances between employe and management, employe and employe and the outside world all find their way to Martin's domain.

Martin doesn't believe he has reached his ultimate goal. He wants a small chapel for his men; one that will seat 150. It won't be a church in the formal sense. Perhaps there will be a small organ. There will be undenominational hymn books.

This is the accomplishment of a man who found that life actually began, for him, at 50.

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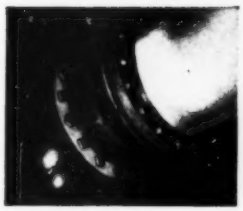
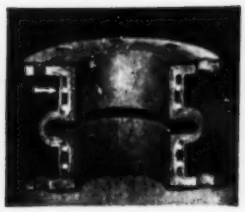
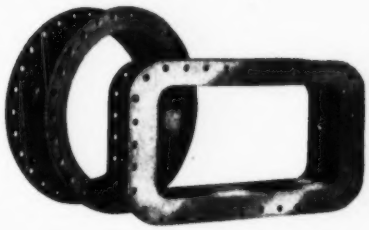


Garlock Rubber Expansion Joint on vacuum line between turbine and condenser

Expansion joints in operation on 2½" suction and discharge pipes



Sectional view shows sturdy construction of single arch joint. Arrow points to one of steel reinforcing rings



GARLOCK RUBBER EXPANSION JOINTS

- Stop Vibration, Eliminate Noise
- Relieve Stresses and Strains in Piping and Equipment

Garlock rubber expansion joints absorb vibration and compensate for linear expansion and contraction of pipe lines. They stand up under repeated flexing—do not crack or fracture.

These flexible joints are made in all pipe sizes from ¾" to 72". Furnished in round, rectangular, tapered or offset; spool-type and U-type. Garlock expansion joints are available in neoprene for oil service; in all "Teflon" or rubber with "Teflon" liner for chemical service.

Write today for new Rubber Expansion Joint Folder No. AD-137.

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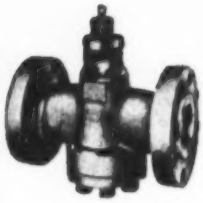
GARLOCK

PACKINGS, GASKETS, OIL SEALS, MECHANICAL SEALS, RUBBER EXPANSION JOINTS

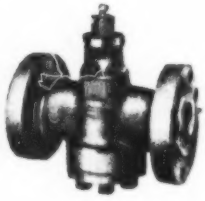
THIS  is a remarkable valve, as

Lubricant goes in through

grooves in the plug . . . . and body

three things—it lubricates the seat . . .

acts as a hydraulic jack . . . . to keep the

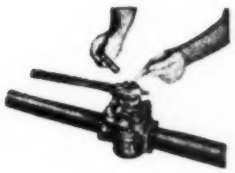
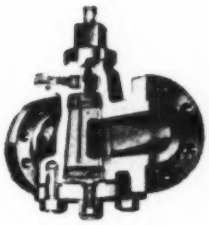
this valve  is safer, because it can

because lubricant stops seepage

because, by eliminating friction

most valves. What kind of valve is it?

by **ROCKWELL** Manufacturing Company,

you will quickly see when you look inside the stem  and is forced through  . . In service, this lubricant does —it seals off the seating area . . .and it plug in position to turn easily. Consequently always be operated in an emergency, and, before it starts. It's also more economical and abrasion, lasts much longer than

Naturally, it's **ROCKWELL-NORDSTROM,**

Pittsburgh 8, Pennsylvania.

Canadian Licensee:
Peacock Brothers Limited

Where's the Fire?

Fire extinguishment in oil processing, storage and transport facilities. Part IV.

H. B. Williams, Director,
Safety and Fire Protection,
Pan American Refining Corporation,
Texas City, Texas

Spheroid—Containing Product Below 13-Pound RVP Fire Below Liquid Level

1. Apply cooling water streams to the vapor line assembly and to the tank top so the run-off will cover the shell completely. Cooling streams should be maintained after flame extinguishment until all danger of re-ignition from hot steel has been eliminated. Apply cooling streams in an adequate manner to threaten tanks.

2. Stop movement of product to the tank unless it becomes necessary to avoid pulling a vacuum caused by cooling. In such event butane or fuel gas may be added as required.

3. Regulate firewall drain valves as required to remove water from the tank basin at a rate that will maintain a liquid seal over the sewer opening. This is to prevent propagation of flames through sewer lines.

4. If the source of fuel is from a flame leak or cracked seam and the flow is not excessive, apply water fog or spray until all danger of re-ignition from hot steel is eliminated; simultaneously switch from water to dry power to effect extingishment.

5. If the flow of flammable material from the tank is excessive, use all available chemical foam generating and deluge equipment to build and maintain a heavy blanket of foam in the tank basin in order to confine the fire to the three dimensional area.

6. Introduce fuel gas to the tank in order to maintain a positive pressure within the tank and pump out product to unaffected storage.

7. When pump-out has reached the limit as determined by available storage, pump operation, etc., refill the tank with water to float the remaining flammable material above the point of leakage.

As soon as the water flow has been established, the flow of fuel gas should be shut off to avoid excessive internal pressure.

When the flammable material has been floated above the leak, the flames will be extinguished. Water pumping should continue, however, until it has been determined that *water* is flowing through the vapor line.

8. Shut off water supply to the tank.

9. Discontinue all cooling water streams.

10. Extinguish the remaining fires around the tank and in the basin with foam.

11. Open the firewall drain valves and flush all flammable material remaining in the tank basin to the separator.

Cone Roof or Breather Roof Tanks Crude Oils—Low Flash Oils (100 F. and below) Intermediate Flash Oils (100-200 F.)

1. Extinguish fires in the firewall basin with foam to reduce heat input to tank contents.

2. Apply cooling water streams to the tank shell and intact portion of roof if roof has not blown clear, providing the run-off does not enter the tank. Avoid directing any water stream into the tank as this will destroy the foam blanket.

3. Apply chemical foam through all fixed foam connections by means of portable foam generators.

4. In case of destruction of one or more fixed foam connections by roof failure, foam should be applied through a corresponding number of portable towers discharging over the tank rim.

5. Open firewall drain valves to full capacity to avoid flooding of the firewall basin.

6. Apply cooling water to other tanks exposed to heat of fire.

Cone or Breather Roof Tanks Bunker "C" and Asphalt (Not Cut-Back)

(Note: Cut-back asphalt is to be considered as intermediate flash oil.)

1. Extinguish ground fires in the firewall basin with high pressure water fog, water spray, or straight water streams applied from firewall, to reduce heat input to tank contents.

2. Apply cooling water streams to the tank shell. Avoid directing *heavy streams* of water into the tank as this will cause slop-over from frothing.

3. Regulate firewall drain valves to maintain a water level approximately one half foot deep at the tank shell. This will assist in fire control in case of a slop-over and will prevent heavy oils from entering the sewer.

4. If the roof has blown clear, direct water streams high into the air so *fine water spray* will fall through the flames into the burning oil. If the roof has been partially lifted, high pressure water fog can be applied through the opening. Application of water by either method must be done in intermittent waves to avoid a slop-over. Continue until extinguishment is complete.

5. Do not apply chemical foam to the tank as this will cause violent frothing and a slop-over.

INCENTIVES

Continued from Page 111

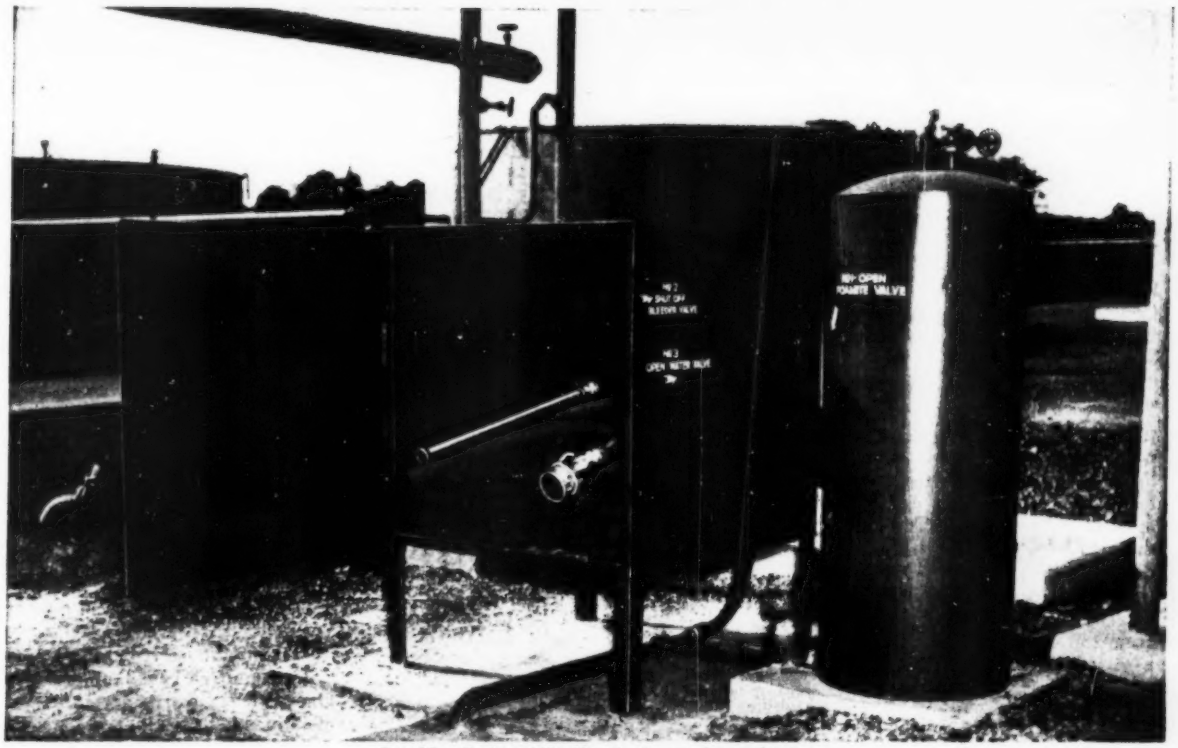
ideas in a businesslike way and as a business undertaking. A suggestion system should not be operated as a sales loss leader for employe relations. If a management considers improved morale as the prime objective of a system, that is too soft an attitude towards making the system pay for itself. Unless a suggestion system is returning improvements for the company which can be proven—that produce tangible results in terms of company benefit irrespective of the return to the employes it should be revised or discontinued.

A suggestion system can be operated successfully and profitably for management in any company in this country if the proper conditions of support and management attitude are present.

As far as the capacity of the usual employe to be alert to ideas for improvement, it is a rare one who won't make a try if the opportunity and encouragement are given to him.

If a company through its employe suggestion plan is getting a satisfactory number of improvements from the total number of suggestions received—at a

Concluded on Page 232



One of Four Rockwood Fire Hose Stations at a large refinery.

First aid for burning tanks

The unpretentious box and tank above act as a first aid station for the huge oil tanks in the background.

They're one of four Rockwood Fire Hose Stations at a large refinery. In case of fire, these stations provide much-needed, on-the-spot protection until regular equipment arrives.

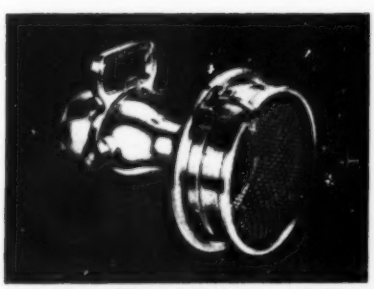
The box contains a 1½-inch In-line Rockwood Eductor, a 1½-inch FFF Rockwood FogFOAM Nozzle with FogFOAM screen attached, a 1½-inch Rockwood FOAM Shaper and 350 feet of 1½-inch rubber hose. The tank contains 125 gallons of powerful Rockwood FOAM liquid which, mixed with water and discharged through the FogFOAM nozzle, provides 20,000 gallons of fire-eating Rockwood FogFOAM. What's more, it remains in operation as long as 35 minutes — as against 4-minute fire protection from old style hand extinguishers.

Neat, and compact, Rockwood Fire Hose Stations are another typical example of the way in which Rockwood engineers water to cut fire losses.

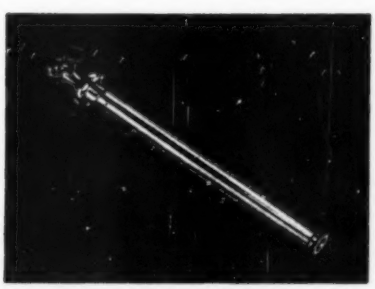
ROCKWOOD SPRINKLER COMPANY

Engineers Water . . . to Cut Fire Losses

PORTABLE FIRE PROTECTION DIVISION



Rockwood Type FFF FogFOAM Nozzle with FogFOAM Screen. Available for service on 1½", 2½" and 3½" fire hose lines. Discharges FogFOAM, Solid FOAM Stream and High Velocity WaterFOG. Approved by Underwriters Laboratories, Inc.



Rockwood Type FFF FogFOAM Nozzle with Long Foam Shaper. FogFOAM pattern reaches a distance of approximately 20 feet. Solid FOAM Stream approximately 45 feet. Discharges 50 g.p.m. @ 100 psi.

SEND FOR THIS INFORMATIVE BOOKLET

ROCKWOOD SPRINKLER COMPANY
Portable Fire Protection Division
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Please send me your illustrated booklet on Rockwood fire-fighting products.

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For more data on advertised products, use Readers' Service Cards, last page.

Don't Discard Your Cardiacs

Employing people with heart ailments is not only the human thing to do—it's good for your business.

Robert L. King, M.D., President, American Heart Association,
Clinical Associate Professor of Medicine,
University of Washington School of Medicine,
Seattle

Too often the community discards productive human beings, not through callousness or lack of concern, but through ignorance of the facts. The facts are that cardiacs can work and most of them do work. The facts show that cardiacs work as well and produce as much on the job as workers without heart disease. These facts are evident from studies in industry and from the day-in day-out experience of many of our top industrial enterprises, large and small.

"Cardiac" is a kind of short-cut term used to refer to people with any kind of disease of the heart or blood vessels. There are more than 20 diseases of the heart and blood vessels, and someone having any one of them could qualify as a "cardiac."

Three Varieties—90 Percent—The three varieties most frequently encountered, the ones that account for more than 90 percent of all heart and blood vessel diseases, are:

Heart disease resulting from arteriosclerosis,

Rheumatic heart disease, resulting from scarring of the valves and heart muscle in rheumatic fever,

Hypertensive heart disease, resulting from a long siege of high blood pressure.

As Management Sees It . . .

Having heart disease is not the prominent professional or personal characteristic of these people called cardiacs. These "cardiacs," these people with heart disease, are human beings, citizens, workers, family men.

The important fact to remember is that cardiacs can and do work. And that many cardiacs who are not working now could become self-supporting if they were placed in suitable jobs.

What kind of work can cardiacs do? Almost any kind for which they are qualified. A recent study showed that more than 8 out of 10 cardiacs who returned to work were able to go back to their old jobs.

Whether the cardiac worker is to be considered handicapped—handicapped in his work and a handicap to his community and to his family—whether he is to be considered handicapped depends on whether or not he is properly and selectively placed in industry. When he is so placed, his skills are salvaged for industry and his life and self-respect are salvaged too.

One of the major concerns of heart associations is to see that workers with heart disease are put in a position to contribute to the community rather than to receive contributions from it.

What are heart associations doing about it?

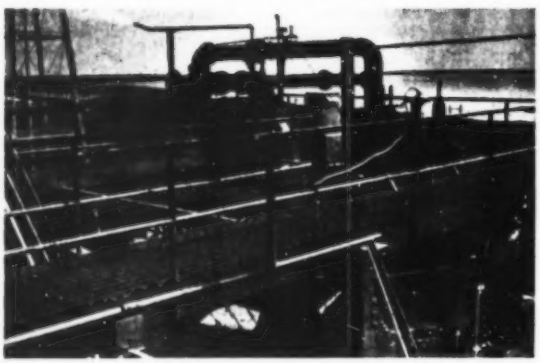
Function of Committee—Many of our affiliates have a special committee, a Cardiac in Industry Committee, composed of physicians, personnel men, union representatives, people in employment services, rehabilitation and other social agencies. The purpose of this committee is to explore the situation of the cardiac in the community, and his relation to industry, to exchange information, to take steps to inform others and to present the facts about the cardiac and his industrial opportunities to the entire locality.

This is just a beginning.

One of the practical results of such a committee is the work classification unit. Sometimes it is called a work evaluation unit. The purpose of the work classification unit is to evaluate the work capacities of the cardiac in light of his total physical, emotional and environmental stresses. The goal is to match the worker's capabilities with the demands of a specific job.

These work classification units (and there are now about 25 of them across the country), are usually set up in a hospital or in a rehabilitation center. Typically, a unit is staffed by a physician, a medical social worker, a vocational counsellor, and other specialized personnel, for example, a psychiatrist,

WHERE **SURE FOOTEDNESS** COUNTS



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STEEL GRATING MAKES WALKS SAFER

Sturdy, one-piece construction with tops of all bars flush provides open steel flooring and stairs for safe, easier walking. Gary Grating is furnished in a wide variety of neat appearing designs and sizes—and is tailor-made to fit your needs. For complete description and installation pictures on Gary Welded Grating, Stair Treads and Gary-Irving Decking, ask for Catalog PR-61.

FREE SAMPLE
We'll send this handy paper weight if you request it on your company stationery.

Standard Steel Spring Division
ROCKWELL SPRING AND AXLE CO.
4011 East Seventh Avenue • Gary, Indiana

PETROLEUM CHEMICALS DIVISION
NEWS

June ★ One of a Series of Interest to the Petroleum Industry ★ 1954

A Dash of Color for Your Rail Sidings

Clean, brightly painted refineries, terminals, tank farms and service stations have become attractive additions to our industrial landscape.

Now the Du Pont Petroleum Chemicals Division is having its tetraethyl lead tank cars painted according to a new color scheme.

In the future, the top half of the cars will be a vivid yellow . . . the bottom half a rich green. The Du Pont ovals will be set off in red and white.

We think you'll find this new color combination pleasing, and our cars an attractive feature on your rail sidings.

Survey Findings on Gasoline Copper Content

Some highly interesting information was obtained in a recent Du Pont gasoline quality survey which included copper content analysis.

Of 241 service station samples from 44 U. S. and Canadian cities, 91% were found to contain copper in amounts from .01 to .90 mg/liter. Less than .01 mg/liter concentrations of copper can, in many cases, have an adverse effect on gasoline stability.

Where Does Copper Enter?

Even with stringent refinery control, gasoline often comes in contact with copper in the distribution system. Valves, pumps and other equipment are believed to be the source.

Gum Content

As part of the complete analysis, tests were made to determine gum content of the samples.

As you would suspect, gum concentrations were low in samples known to contain Metal Deactivator. In those with no deactivator, gum content was high. In some cases it appears that not enough deactivator is added to achieve maximum stability all along the line.

Du Pont Metal Deactivator minimizes the gum-forming action of copper. In most cases, it protects for less than 1/5 cent per barrel.

Any Du Pont Petroleum Chemicals Division regional office can give you added facts in connection with the gum problem.

These Services Can Help You Promote Employee Safety

As a refiner, you have a special safety problem due to the occupational hazards of handling tetraethyl lead.

To help you lick this problem as easily and efficiently as possible, the Du Pont Petroleum Chemicals Division makes a broad range of safety and medical services available to you. As an executive interested in and responsible for the safety of your workers, you will want to know how you can simplify your work by taking advantage of these important services.

INTEREST-AROUSING VISUAL AIDS are widely used by Du Pont representatives in safety talks and presentations.

Here are some of the ways in which these services can be valuable as a supplement to your own safety and medical programs.

Training Aid

As a training aid, the Du Pont Lead Hazard Clinic covers the broad psychology of industrial safety as well as *all* phases of safe TEL handling.

It is primarily designed as an educational tool and refresher course for supervisory personnel. It is also ideally suited for training members of crews concerned with TEL handling and with maintenance connected with leaded gasoline tanks.

To Keep Interest Lively

Workers easily become bored – and sometimes careless – when safety programs are presented over and over again in the same way.

To help refiners overcome this situation, Du Pont is constantly preparing new, interest-arousing visual aids. Your men will find them easy to under-

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

DU PONT

PETROLEUM CHEMICALS DIVISION
NEWS

DU PONT

CONTINUED

Safety Services

stand and remember. They are available in a variety of forms – including booklets, tip-overs and sound-slide films.

Advisory Service

Whenever it is necessary for cleaning or repair crews to enter a leaded tank, Du Pont will be glad to send a qualified representative to confer with the men on the safety procedures involved.

This service can be quickly obtained by telephone or telegraph and can be scheduled to fit in conveniently with your over-all operations.

For Authoritative Reference

The medical aspects of TEL handling fall into a highly specialized field.

Recognizing the need for an authoritative book on the subject, three Du Pont physicians recently wrote and published "Maintaining Hygiene in Tetraethyl Lead Operations." This book can be extremely helpful as a reference work and training aid for refinery doctors. Because of its specialized character, it is designed for limited distribution to physicians and management personnel only.

YOUR WORKERS get individual, personalized instruction from Du Pont safety representatives.

For Safety Meetings

Occasionally you may find it desirable to bring in outside speakers to discuss the safety and the medical aspects of TEL handling. For such meetings, or meetings involving other safety subjects, the safety and medical staffs of the Du Pont Petroleum Chemicals Division will be glad to send special representatives trained in public speaking. Their talks to employee groups are always penetrating and provocative.

Du Pont has also prepared a full-color Hollywood movie on tank truck operation and safety. This is an excellent tool for training drivers on their highway responsibilities. Unlike many commercial films, this one has plot, drama and humor that entertains while it trains.

In addition, Du Pont will be glad to help you solve any general safety problems individual to your refinery.

To put these important services to work, just get in touch with any Petroleum Chemicals Division representative or regional office.

ADDITIVES SALES COORDINATOR

WILLIAM T. ROBINSON is a special assistant to the sales manager of the Du Pont Petroleum Chemicals Division. In this capacity he coordinates sales of Du Pont Metal Deactivator, antioxidants, gasoline dyes, Fuel Oil Additive No. 2, "Ortholeum" 300 Grease Stabilizer and various other Du Pont additives. Prior to this assignment, he was employed in the Division's Technical Section.

After graduating from St. Vincent College in Latrobe, Pennsylvania, with a B. S. in Chemistry, Mr. Robinson became a laboratory chemist at the Texas Company. He then joined Universal Oil Products as a sales-service representative and came to the Du Pont Company in 1952.

During World War II he served in the Navy as commanding officer of a PT boat and later a minesweeper. He is a member of the American Chemical Society and a committee member in the Coordinating Research Council.

MOVIES AVAILABLE

You can easily obtain a wide selection of motion pictures from the Du Pont Petroleum Chemicals Division Film Library, free of charge.

Among them are many films specially tailored for oil company use in dealer meetings, public relations and employee training. A number of them are also ideal for showing to customer groups for sales purposes.

In addition to films on specific oil industry subjects, the Du Pont "Cavalcade of America" television program film library is available to you. These 26-minute sound movies about historical Americans are ideal for tying in with your own public relations showings at schools and service clubs, as well as for employee recreation.

FOR READY REFERENCE, this new catalog lists the films available to you through the Du Pont Petroleum Chemicals Division Film Library. Any of our regional offices will be glad to send you a copy.

DU PONT

Better Things for Better Living
. . . through Chemistry

Petroleum Chemicals

E. I. DU PONT DE NEMOURS & COMPANY (INC.)
Petroleum Chemicals Division • *Wilmington 98, Delaware*

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HOUSTON, TEXAS—705 Bank of Commerce Bldg.	Phone PRestan 2857
LOS ANGELES, CALIF.—612 So. Flower St.	Phone MAdison 5-1691

IN CANADA: Canadian Industries Limited—Toronto, Ont.—Montreal, Que.—Calgary, Alta.
OTHER COUNTRIES: Petroleum Chemicals Export—Nemours Bldg., 6539—Wilmington 98, Del.

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

A-7431

Printed in U. S. A.

if available, to assist in straightening out mental and emotional conflicts that may have arisen as a result of fears accompanying the heart trouble.

A work classification unit with a specialized staff can be a resource for management as well as for the worker. After all, the employer has an economic interest in protecting his investment in the skills of his employes who develop heart disease.

The staff of the unit can advise as to the wisdom of the employe's returning to his old job; they can suggest whether a transfer or some modification of job conditions is necessary; they can advise whether the patient is capable of working at all.

How Unit Operates—The true story of Frank Porter, illustrates how a work classification unit can function.

Frank had worked for the "x" company for 17 years when he had his heart attack. Then came a three-month period of rest and recovery for Frank. Frank wanted to go back to work, but he was afraid—afraid his heart could not take it.

Frank's employer wanted him back at work; Frank was a good employe; the company needed his skills. But Frank's employer was doubtful whether Frank was up to the job.

The union was interested in Frank but they were uncertain as to how they could help him.

Frank's physician suggested that the local work classification unit might be able to provide some answers to the questions, the doubts, the fears.

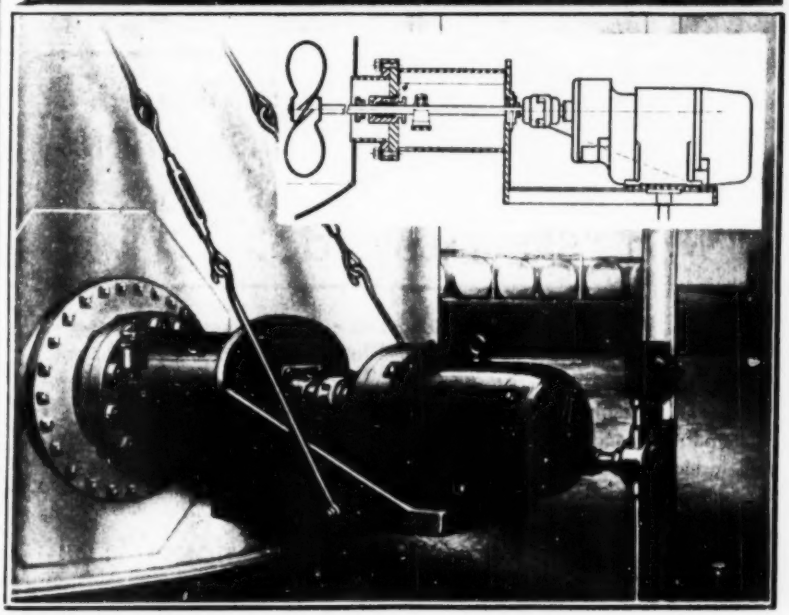
There the results of modern scientific examinations and tests were correlated by the physician and judgment made on the patient's physical condition. The medical social worker helped Frank face and evaluate his fears, and assessed the physical and emotional stresses of his environment.

The vocational counsellor reviewed with Frank his life's work and experience and hobbies that might offer some clue to a new kind of work if this should be necessary. He reviewed with Frank the physical demands and pressures of the old job. With the foreman, he discussed the job requirements and asked about less demanding jobs that might use similar skills.

Members of the work classification team then pooled their information and their judgment and agreed upon a decision. A full report was sent to Frank's physician. Frank agreed to release the facts to the company.

Back on Old Job!—Once Frank knew what he could do and could not do, he felt much better. He returned

International's Type "NU" SIDE ENTERING MIXER



Wins fast acceptance! Users say it meets all requirements. Costs less to buy and Fully Guaranteed!

Here is a mixer that has no cast parts, being of all-welded construction, including the stuffing box,—nothing to break or get out of order. And due to its strong, simple construction it is replacing many complicated, and higher priced units. It is recommended for the most efficient, rapid and economical blending of gasoline, gasoline Ethyl mixing, lubricating and fuel oil blending as well as by-products. Indispensable in cycling operations and pipe line work—uniformity in charging stock—a natural for research, laboratory and pilot plants.

12 SIZES — FROM ½ TO 25 H. P.

This unit has two ball bearings, and a front single lantern bearing on the shaft, thus giving three bearing supports to the overhung propeller shaft. Quick access to the front ball bearing and the stuffing box gland is obtained by opening the hinged cover door on top. Repacked from outside without tank leakage. . achieved by the same positive arrangement as our other models.

If you have a mixing problem, we invite you to write us for Catalogs and any special Engineering information you may need. There is no obligation of course.

Look to International
FOR DEPENDABLE MIXING EQUIPMENT

INTERNATIONAL ENGINEERING, INC.
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NEW YORK 15 PARK ROW WORTH 2-2580
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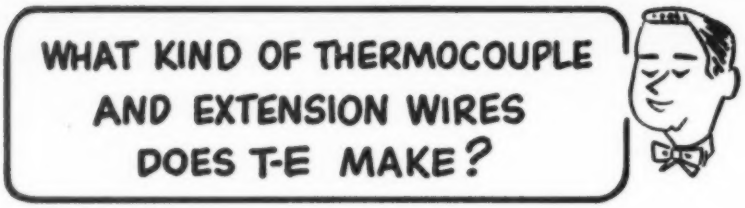
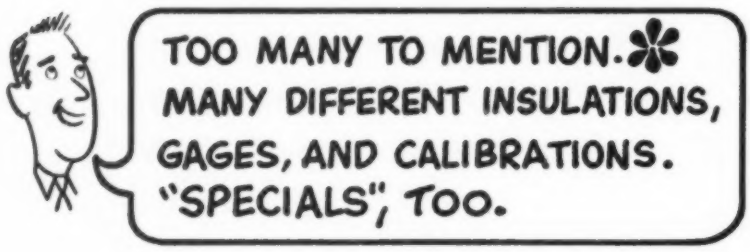




Thermo Electric makes thermocouple and extension wires to "MIL" specifications and industrial standards. Each step in their production, from wire drawing and insulating to final testing, is handled carefully in T-E's own plant. Furthermore, T-E's engineers will develop special wires or cables you may need for unusual pyrometric applications. Most standard wires, including MIL-W-5845, 5846, and 5908, in all types and classes, are shipped from stock, specials are produced promptly.

THREE, STANDARD, T-E INSULATIONS

NN—nylon insulated conductors, nylon overall—provides excellent protection against abrasion.

TG—teflon insulated conductors, hi-temp varnish-saturated fiberglass overall—protects wires from moisture and petroleum products at temperatures up to 600°F.

HGHG—hi-temp fiberglass insulated conductors, hi-temp fiberglass overall—suitable for temperatures up to 2000°F.

* There are too many T-E wires to mention comfortably in one ad. However, in T-E's Wire Bulletin, you can see four pages of insulated wires, their gages, and calibrations. And, there's more: a page of charts shows calibration symbols, color codes, and insulation characteristics. Two additional pages contain engineering data: resistances of solid and stranded conductors, weights, electrical properties, and conduit capacities. Write for your copy—ask for Bulletin X.

Pyrometers • Thermocouples • Protection Tubes • Quick-Coupling Connectors
Thermocouple and Extension Wires • Resistance Bulbs • Connector Panels

Thermo Electric Co., Inc.

SADDLE RIVER TOWNSHIP, ROCHELLE PARK POST OFFICE, NEW JERSEY
IN CANADA—THERMO ELECTRIC (Canada) Ltd., BRAMPTON, ONTARIO

As Management Sees It . . .

to his old job. The employer was glad to change one aspect that required heavy lifting, and the union agreed to the minor change. Frank joined a car pool to make travel to and from work easier. His son quit his after-school job to take over Frank's old chores.

Frank Porter is again a man who can take care of himself and his family—a man who can live a good life with only minor restrictions.

We doctors, and we heart associations, are realistic enough to recognize that not every man is capable of competitive employment. We do not expect industry to "carry" a cardiac worker if the worker is not productive.

Our aim is simply to encourage all persons concerned to examine the facts. Fear feeds on ignorance and prejudice feeds on fear. Our national effort is to search in all areas for the facts and to make these facts known. Our program, the program of the American Heart Association, is a happy combination of research and service. While half our funds are allocated to scientific and medical research, the other half are devoted to community service and education as a means to applying the facts we do know. Through our National Committee on the Cardiac in Industry we are concentrating efforts on problems and solutions of the cardiac in industry.

We believe that through our committee efforts, through our work classification units, through our publications, we have something to offer industry, both management and labor.

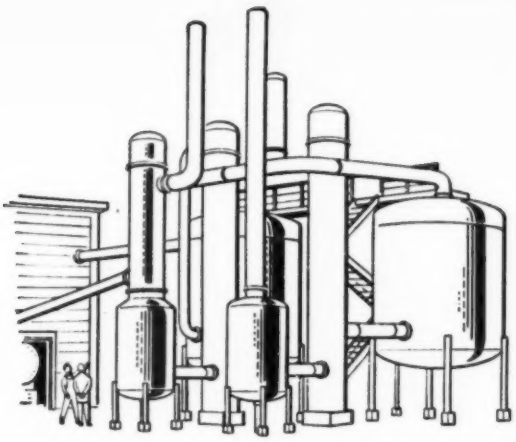
Original presentation as "What the American Heart Association Offers Industry" was before the sixth Industrial Health Conference in Houston.

INCENTIVES

Continued from Page 226

reasonable cost of administration—for that company the plan can be considered as paying for itself. The activities of installing and administering a productive system can be reviewed in the experience of hundreds of companies. This experience is so available and in such detail that a failure or an ineffective system is truly a failure of a management to plan for its success. The many profitable systems in operation are testimony to the rewards and recognition they hold out to employes. These active incentives can help to arrest the slow national decay in employe faith in the rewards of personal initiative and individual effort.

(The concluding part of this series will be published in an early isue.)



DON'T BURN PROFITS!

Extra profits from your refinery or natural gas operation are going up in smoke if you aren't producing sulphur from your waste hydrogen sulphide. With a Pritchard-built sulphur recovery plant, you can eliminate air pollution and economically convert that dangerous liability into a highly profitable asset—elemental sulphur.

Pritchard is a licensing agent for Stanolind Oil and Gas Company's new patented processes, practical design data and operating specifications to provide efficient sulphur recovery.

Write today for information on how a Pritchard-built sulphur recovery plant can eliminate air pollution and produce extra profits for you.

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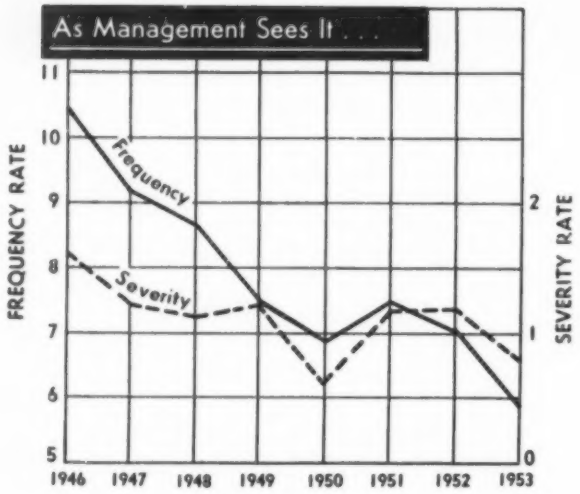


Figure 1. Injury rates of refining.

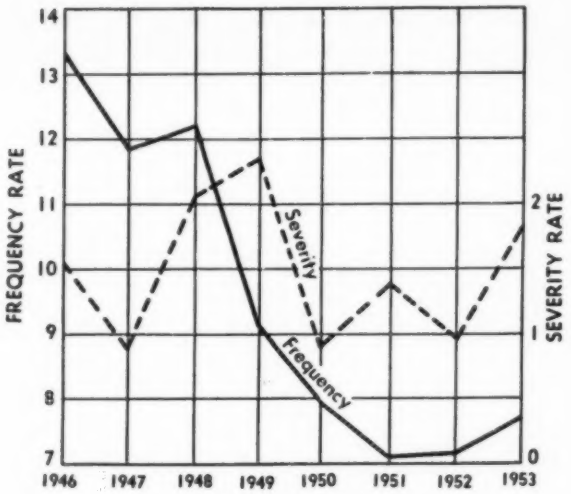


Figure 2. Injury rates of natural gasoline.

(Frequency rate is the number of disabling injuries per one million hours worked. Severity rate is the number of days lost per one thousand hours worked.)

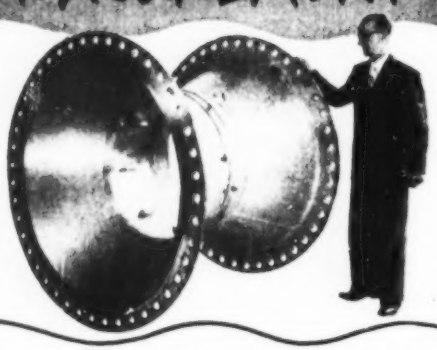
Refining Has Safest Year

The refining field continued its postwar safety improvement trend in 1953, posting a new low frequency rate of disabling injuries of 5.90.

FOR FLOW MEASUREMENT

only the Gentile FLOW TUBE manufactured by FOSTER offers you all these ADVANTAGES:*

*Gen-til-'ly



ACCURACY — Produces differential from points of equal cross-sectional area . . . furnished with head capacity curves, and guaranteed for exceptional accuracy when used with any standard indicating, recording or integrating meter.

LOW HEAD LOSS — Available in several types and D/d ratios to provide differentials that can be accurately measured with least head loss.

LOW INSTALLED COST — Average length is only 1½ times the pipe diameter, and straight runs entering and following are not required unless installed near throttling valves or regulators.

Write for Bulletin FT-101 or specific recommendations

FOSTER ENGINEERING COMPANY

835 LEHIGH AVENUE — UNION, N. J.

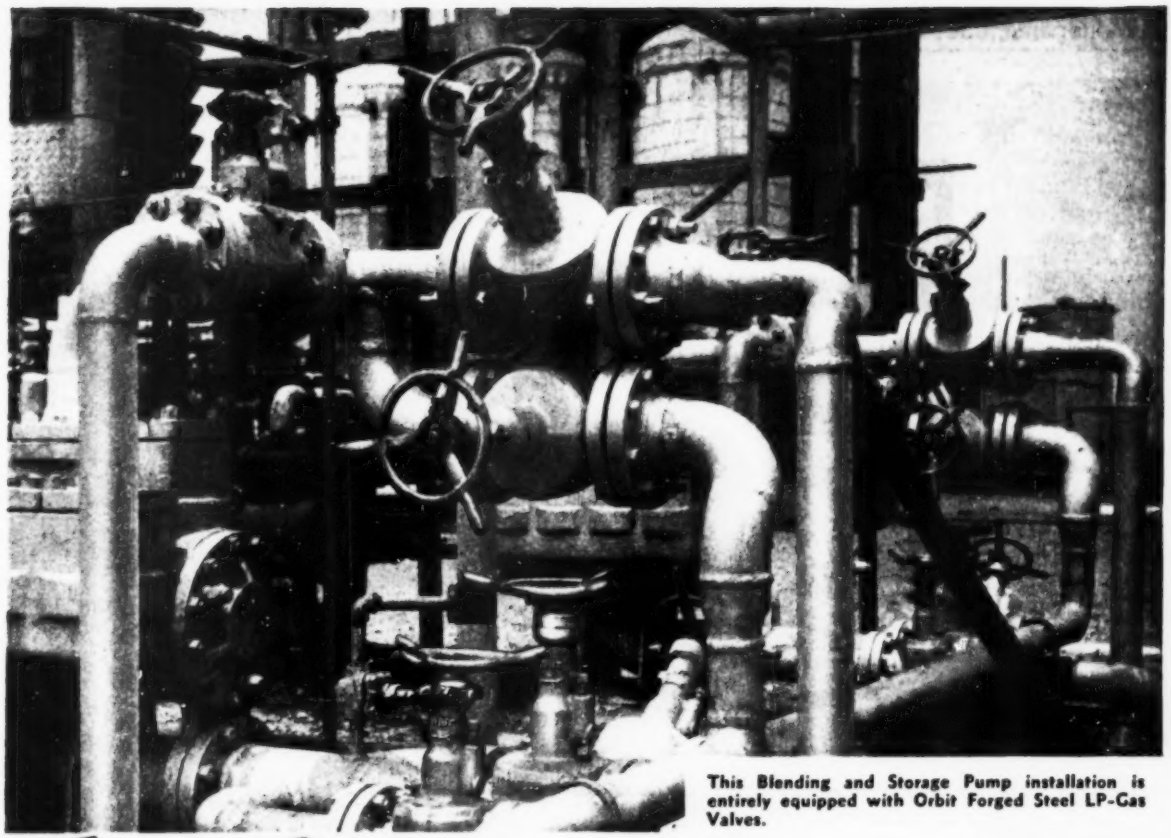
AUTOMATIC VALVES • SAFETY VALVES • FLOW TUBES

SAFETYWISE 1953 was a banner year for the refining field. Its frequency rate of disabling injuries per one million hours worked dropped to 5.90, a 15.9 percent improvement over 1952; and its severity rate of injuries sustained declined sharply from 1.18 in 1952 to 0.80. (See Figure 1.)

Since 1946 the refining field has had an over-all drop in frequency of disabling injuries of 44 percent, tops in safety performance improvement in the oil industry. Considering the expansions and characteristics of the many new products handled during this postwar period, the record is even more commendable.

The natural gasoline field, while improving its frequency rate by 41.5 percent during the postwar period, has lost ground in the last two years from its best performance in 1951, when its frequency rate hit a low of 7.08. (See Figure 2.) Its 1953 severity rate was the highest since 1949.

Possible reason for the rise in the frequency and severity rates in this field is the increase in plants and employes. But there are also strong indications that the natural gasoline plant operators have not given sufficient time to safety training and practices to keep the field in step with the improved performances recorded in the refining field and in the petroleum industry as a whole.



This Blending and Storage Pump installation is entirely equipped with Orbit Forged Steel LP-Gas Valves.

First Choice for Handling Light Ends

Orbit Forged Steel LP-Gas Valves insure a vapor tight shut-off, eliminating contamination. Reruns are eliminated and product quality is maintained. Besides there are no voids in the body of an Orbit LP-Gas Valve to trap fluids that could become dangerous in case of fire. When the valve is closed it drains clean to either side of the line — in case of reversed pressures it still holds vapor tight.

Adjustable plastic stem packing is utilized that can be added to, if necessary, while the valve is in service and under pressure.

Orbit LP-Gas Valves are competitively priced. They soon pay for themselves through high type performance and low-cost maintenance. Orbit's Friction Free Seating Principle account for these advantages.

Include Orbit LP-Gas Valves on your next blue prints for a new Hydrocarbon Plant or expansion program. Install them when making replacements within your plant. Many other uses include underground and surface storage installations, tank car and truck loading racks. Orbit LP-Gas Valves carry Underwriter's Laboratory approval which you will find clearly stenciled on the body of each valve.

These valves are full round opening and available in both flange and screw ends, ASA Class. Maximum rated working temperature 250 Degrees Fahrenheit. They are all forged steel — welded bonnet construction.

Sold through Oil Field and Refinery Supply Stores throughout the country.

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ORBIT VALVES ®

P. O. BOX 699 TULSA, OKLAHOMA

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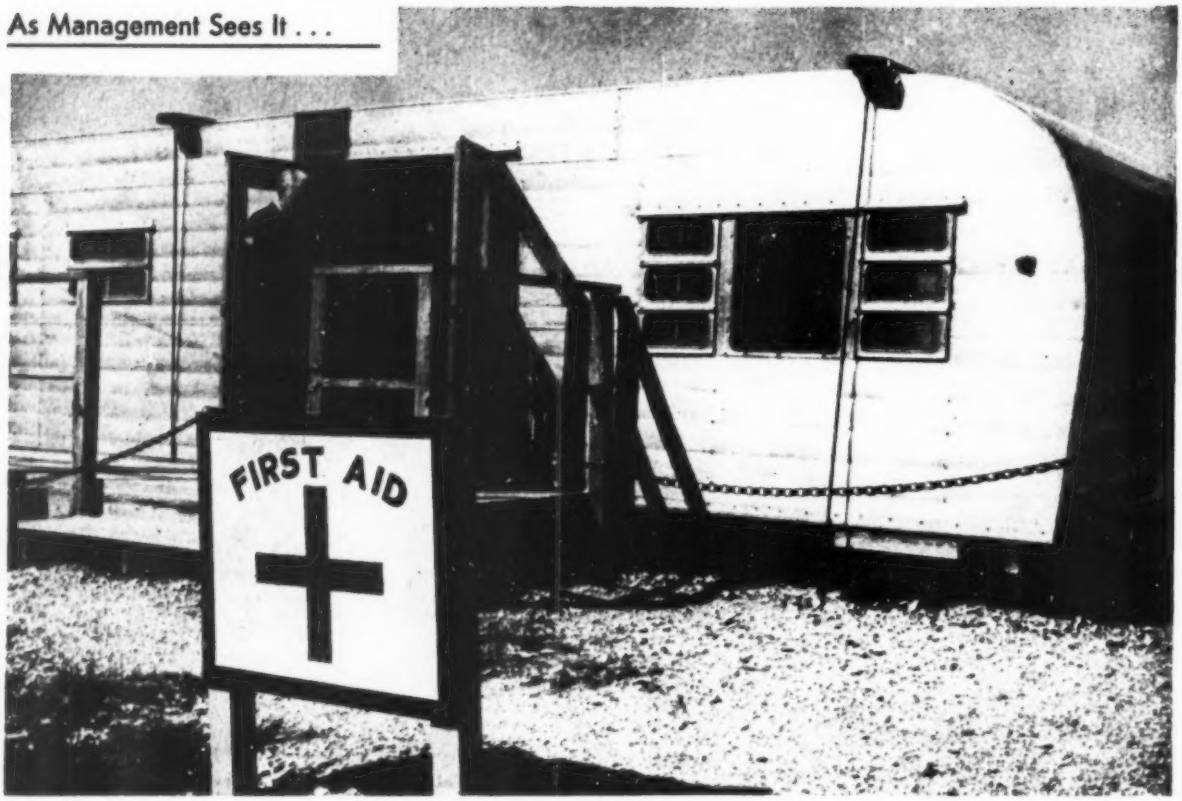

Dr. M. E. Thompson, Dow hospital administrator, enters the first aid trailer.

Trailer Takes First Aid To Workers

Nurse I. S. Sharp interviews "customers" of the mobile first aid trailer.

EFFECTIVE industrial first aid services must be close to the people they serve, it is believed at The Dow Chemical Company's Texas Division in Freeport.

Answering that problem at Freeport demanded unusual measures, for plant expansion programs were constantly moving employes farther from the division's three permanent first aid stations. Since most of the heavy concentrations of personnel were temporary, it was not feasible to set up new permanent first aid stations.

Mobility was obtained with a custom-fitted trailer which could be moved about and hooked up to pre-arranged electrical, water, sewage and telephone lines in less than an hour.

The 41-foot trailer, equipped with facilities ranging from oxygen tanks to a refrigerator for storing perishable medicines, handled 84 first aid cases the first week it was in operation, and 361 in the first month.

A registered nurse staffs the trailer in operation. For injuries needing the attention of a doctor or the facilities of a hospital, the industrial doctor's office and the Dow Hotel are available.

As rugged as they look!

REPUBLIC ALLOY STEEL STUDS

RESIST HIGH PRESSURE – HIGH TEMPERATURE – CORROSION

● It's the high-tensile strength in Republic Alloy Steel that does the trick. Uniform alloy structure gives these studs calculated strength that can be relied on – even under extreme corrosion, temperature and pressure conditions.

Sharp, accurate threads provide maximum holding power, resistance to wear, easy tightening – yet permit backing off with minimum effort.

Specify Republic Alloy Steel Studs for your next new pressure vessel order. Be sure to carry them in stock for replacements.

REPUBLIC STEEL CORPORATION
Bolt and Nut Division • Cleveland 13, Ohio
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, N. Y.

REPUBLIC BOLTS AND NUTS

Other Republic Products include Carbon, Alloy and Stainless Steels—Bolts and Nuts, Steel and Plastic Pipe, Heat Exchanger Tubes.

For more data on advertised products, use Readers' Service Cards, last page.

What's Happening in the Industry . . .

Independent Refiners to Push Action on Imports

The petroleum import problem has come in for much attention lately, in recent meetings of the Independent Producers Association of America, coal organizations, and the meeting of governors.

A year ago the Independent Refiners Association of America proposed its solution: that Congress declare as a national policy of the U. S. that imports may supplement but must not supplant domestic supplies. Last month the IRAA declared in Washington, D. C., that it would push for immediate consideration its program for solution to the imports problem.

M. H. Robineau, president of IRAA, said that he considers "this a most critical moment . . . efforts toward voluntary action have failed and specific legislation is the only alternative."

Bureau of Mines Would Start Gasification Tests

Funds for the resumption of coal gasification experiments have been requested by the Bureau of Mines, and the request is now being considered by House and Senate appropriation committee.

The Bureau likely would resume the experiments, using Hydrofrac process previously used in rejuvenation of oil wells, in cooperation with Stanolind Oil & Gas Company and Alabama power companies if Congress allows the Bureau its share of the cost. It is understood that the Bureau and the two companies would contribute one-third each to revive studies at the Gorgas, Ala., gasification project, which has been on a standby basis since May of last year. Estimated total cost of the experiments is $75,000.

Union Oil Names Jameson New Plant Superintendent

Walter T. Jameson has been appointed superintendent of the Santa Maria refinery which Union Oil Company plans to build in San Luis Obispo County, Calif.

Jameson joined Union Oil in June, 1940. He was assigned to the company's Los Angeles refinery in 1951 and a year and a half later was transferred to the Operations department as assistant superintendent.

Panhandle Oil Elects Jones Vice President

Bruce Jones, refinery manager of Panhandle Oil Corporation's Wichita Falls, Texas, refinery, has been elected a vice president. He will continue as manager of the refinery in his new post. Jones joined Panhandle in 1952, having previously been chief project engineer with the Votator division of The Girdler Corporation.

AIChE Award Goes to Sparks—
Dr. William J. Sparks, right, co-inventor of Butyl synthetic rubber, accepts the American Institute of Chemists 1954 Gold Medal Award from Dr. Gustav Egloff, chairman of the Institute's medal award committee. The presentation was made at a ceremony at Asbury Park, N. J., last month. Dr. Sparks is director of the Chemical division of Standard Oil Development Company and coordinator of exploratory research.

Herron Retires at Caltex After 44-Year Service

California Texas Oil Company, Ltd., has announced the retirement of Howard M. Herron from his position as chairman of the executive committee of the Caltex group.

First president of the Caltex group in 1936, Herron has been with the organization 44 year.

Announcement

The Gulf Publishing Company will begin in July a new monthly publication to be known as *Pipe Line Industry*, it was announced by Ray L. Dudley, president and publisher.

The publication will be devoted to all phases of both the oil and gas pipe line branches, according to its publisher, who said the new magazine is in answer to a demand created by the tremendous growth of the industry.

Pipe Line Industry will be a greatly expanded version of the Pipe Line Section of *World Oil*, which henceforth will be devoted to the producing and drilling branches. Donald M. Taylor, the pipe line editor of *World Oil*, will fill the same position on the new magazine, and Warren L. Baker, editorial director of *World Oil*, will occupy that post for *Pipe Line Industry*.

Gulf Publishing Company also publishes PETROLEUM REFINER, serving the refining, petrochemicals and natural gasoline industries; *The Composite Catalog* of Oilfield Equipment for the drilling, producing, pipe line industries, and the *Refiner Catalog*, for the refining, petrochemicals and natural gasoline industries.

Socony Safety Award Won By Italiana Refinery

The Naples, Italy refinery of Socony-Vacuum Italiana, S.P.A. has been declared the 1953 winner of the annual safety contest among nine Socony-Vacuum Oil Company, Inc., refineries in five European countries. The refinery advanced from last place in 1951 to third place in 1952 and to first place in 1953.

A bronze trophy will be presented to the refinery's 1255 employes at ceremonies to be held in Naples. Representatives of the company and officials of the Italian government will participate.

The contest is held annually by Socony-Vacuum to promote programs of accident prevention throughout the manufacturing installations of its affiliated companies in Europe.

New Firm Will Bid for Synthetic Rubber Plant

A new corporation has been organized to bid for the purchase of one of the government-owned synthetic rubber plants to be offered for sale to private industry in the coming months.

American Synthetic Rubber Corporation, incorporated in Delaware with authorized capital of $6.6 million, is jointly owned by 29 firms engaged in the manufacture of rubber products and chemicals.

Thomas Robins, Jr., president of Hewitt-Robins Inc., Stamford, Conn., and also president of Kentucky Synthetic Rubber Corporation, Louisville, headed organization of the venture. Fif-

IT'S YOUR $18,000,000

... who will you trust with it?

WHEN your company invests that kind of money in new plant construction you will have to have confidence—a lot of confidence—in the people you trust with the job.

You can find plenty of evidence of complete confidence in McKee among some of the world's largest corporations in the industries we serve. Most of the big names in these industries have called on us again and again for McKee design, engineering and construction services . . . the type of sound thorough efficient services you want for *your* money.

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Canada: Arthur G. McKee & Company of Canada, Ltd., 350 Bay St., Toronto

ENGINEERS! PURCHASING AGENTS!

Here's America's NEWEST Electronic Source Guide!

1. Alphabetical list of over 700 manufacturers gives: company address, name of sales mgr., brief data on lines produced, plus names, address and telephone number of sales agents.

2. Alphabetical listing of 1000 trade names associates these names with the companies who use them.

3. Buyers guide of electronic components and equipment lists over 300 separate products.

4. Geographical listing of 600 manufacturers representatives supplying names, address, phone numbers; territory covered, and lines handled.

5. Distributors in this section specialize in supplying electronic parts and equipment to industry. Distributors are arranged in geographical sequence under the manufacturers whose lines they stock and sell. Procurement is made easy at the local level.

6. Geographic listing of over 1300 recognized distributors of electronic parts and equipment gives: firm name, address, buyer, owner or executive, trading area served.

10 DAY FREE TRIAL OFFER!

WHO'S WHO IN ELECTRONIC DISTRIBUTION 845 Leader Bldg.
Published by Radio & Electronic Jobber News, Incorporated Cleveland 14, Ohio

Please send me one copy of **WHO'S WHO IN ELECTRONIC DISTRIBUTION** on a **FREE TRIAL BASIS.** In 10 days I will either remit $7.50 to cover the cost or I will return this directory postpaid and notify you to that effect.

Firm Name .....

Address .....

City ..... Zone ..... State .....

Signature ..... Title .....

Refiner simplifies tank car cleaning with new Oakite method

Finds use of Oakite Composition No. 19 and Oakite Fogging Unit saves money, reduces work in removing tenacious asphalt residue

Because of the confined working space, cleaning residues from tank cars often becomes a problem. And especially so when it's sticky asphalt that must be removed. To do this job, one refiner pumped up to 6 inches of hot oil into the car and then pumped it out—repeating the process several times. Results were not too satisfactory. In fact, when a "cleaned" car subsequently went out with fuel oil, a man had to be sent into the field at a cost of $150 to free up the valve which had stuck tight.

Then Oakite was called in and a new technique proposed. The Oakite Man put 80 lbs. of Oakite Composition No. 19 into the car—set the nozzle of the Oakite Fogging Unit into the Oakite cleaner then turned on the steam. Five hours later, the tank was thoroughly clean. All residue had been dislodged and easily rinsed out with water.

Proving that—in industrial cleaning, it pays to bring your problem to Oakite.

YOUR OAKITE TECHNICAL SERVICE REPRESENTATIVE

His experience is yours to draw on. He knows "cleaning engineering" and the conditions under which refinery cleaning can best be performed. His responsibility only begins when you order materials. He keeps in touch with you. He sees to it that the job is done right the first time *at lowest cost.* Call him. No obligation. Oakite Products, Inc., 50B Rector St., New York 6, N. Y.

SPECIALIZED INDUSTRIAL CLEANING

OAKITE

MATERIALS • METHODS • SERVICE

Technical Service Representatives in Principal Cities of U. S. & Canada

teen of the 19 firms comprising Kentucky Synthetic Rubber for the past four years are shareholders in the new firm. Robins is acting as temporary chairman; permanent officers are to be elected after acquisition of a plant.

Tide Water Reorganizes Mid-Continent Operations

The Mid-Continent operations of Tide Water Associated Oil Company has been reorganized and is now headquartered at two division offices, the Central division at Tulsa, and the Southern division at Houston.

J. E. Roth, Tulsa, has been appointed general manager of the Central division, comprising Illinois; Kansas; New Mexico; Oklahoma; Pennsylvania; North, Central and West Texas; Rocky Mountain Area and Western Canada. Tide Water's refinery at Drumright, Okla., and its Mid-Continent marketing operations, will be part of the Central division.

E. B. Miller, Jr., of Houston, has been appointed general manager of the Southern division, comprising Alabama; Arkansas; Florida; Louisiana; Mississippi; and Texas, other than North Central, and West Texas. Lloyd Armstrong, of Houston, has been appointed assistant general manager of the Southern division.

General Petroleum Will Install Recovery Systems

A new vapor recovery system will be installed at the tank truck and tank car loading racks in the two General Petroleum Corporation terminals in Los Angeles county as an air pollution control measure.

The two installations, to cost over $100,000, will incorporate newly designed devices which will trap vapors created by tank truck or tank car loading operations and prevent their escape into the atmosphere. One system will be installed at the company's Torrance refinery and another at its main Los Angeles-area distribution plant at Vernon, Calif. Installation will be completed within six months.

Richfield Controls Smog To Tune of $6.7 Million

For smog-control measures at its newly expanded Watson, Calif., refinery, Richfield Oil Corporation spent $6,737,431. An electrostatic precipator, the world's largest and costing $538,000, will be used as part of the precautions taken to prevent catalyst dust loss from a new catalytic cracker. A $1,200,000 waste heat boiler will burn waste hydrocarbons which would otherwise become contaminants. (For more on the Richfield refinery, see page 113.)

Dow Chemical Institutes New Retirement Plan

A new plan to provide added retirement income for its salaried employes has been announced by The Dow Chemical Company. Separate and distinct from the Dow Pension and Profit-Shar-

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Throughout industry — wherever oxygen content of gases influences or controls chemical processing or combustion operations — Arnold O. Beckman Oxygen Analyzers are establishing completely new standards of accuracy, simplicity and convenience. These are the *only* instruments that make a direct physical measurement on oxygen itself — not of some variable secondary relationship.

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BULLETIN 108: *Describes the Model F-3 Beckman Oxygen Analyzer —the instrument designed primarily for industrial applications such as combustion control, catalyst regeneration, sulfur grinding, etc., which require an oxygen measuring range of 0-5%, 0-10%, 0-15% or higher. Bulletin 108 describes the unique magnetic operating principle used in Model F-3 Analyzers, gives equipment specifications and typical applications for this instrument.*

BULLETIN AD607: *Contains helpful charts and data on most efficient methods of controlling various combustion processes.*

BULLETIN AD610: *Contains helpful data on Chemical Applications, illustrates a typical installation, lists equipment required.*

BULLETIN AD611: *Contains helpful data on Tunnel Kiln Applications, shows typical installation, details equipment required.*

BULLETIN AD613: *Contains helpful data on measuring O_2 content of High Purity Gases, shows typical sampling system, lists equipment required.*

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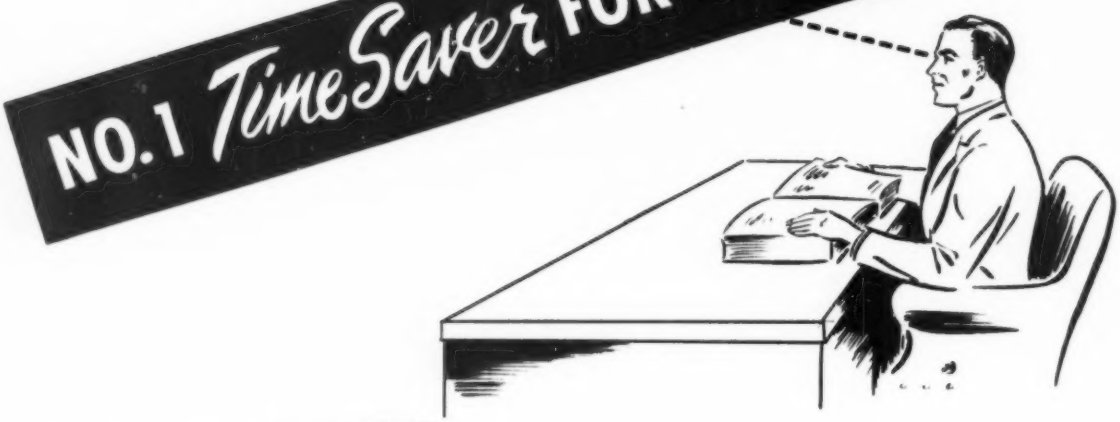

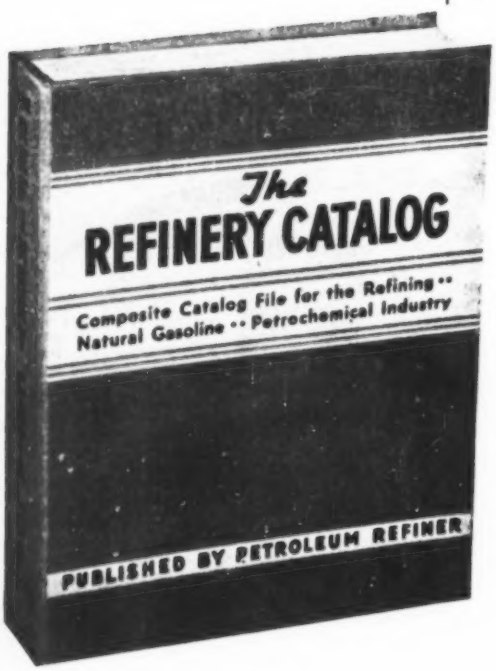
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What's Happening. . .

ing Plan, the new plan is financed through company contributions invested in Dow Common Stock. More than 2000 employes are immediately eligible for membership in the plan, and hundreds more will normally become eligible each year.

General Petroleum Gives Schaafsma New Lab Post

Jan G. Schaafsma has been advanced to assistant manager for General Petroleum Corporation's Laboratories department.

Schaafsma

Schaafsma, who joined General Petroleum in 1934 upon receiving his master's degree in chemical engineering from California Institute of Technology, has been in laboratory work since that time. He was first employed as a junior inspector and, prior to his promotion, had been assistant to the manager since 1947.

He makes his headquarters at General Petroleum's Vernon offices.

Milligan Succeeds Wescoat As President of Pure Oil

Robert L. Milligan, executive vice president of The Pure Oil Company, has been named president succeeding L. S. Wescoat, who has become chairman of the executive committee. The move was prompted by Wescoat reaching the normal retirement age at the company.

J. Porter Langfitt, senior vice president, succeeds Milligan as executive vice president.

Joining Pure's Treasury department in 1929, Milligan advanced to treasurer in 1947 and two years later was elected vice president. He has been executive vice president three years, a director since 1952 and a member of the executive committee since last year.

Until recently Langfitt was in charge of Pure's refineries and has been managing research and development and engineering and patent activities. Wescoat fills a post which has been vacant since the death of Henry L. Dawes over a year ago.

Stanolind Tabs Farnham For Brownsville Post

D. W. Farnham has been transferred to Brownsville, Texas, as synthesis plant superintendent in Stanolind Oil and Gas Company's Chemical Operations section. Formerly division gas superintendent for Stanolind's North Texas-New Mexico division, he is succeeded by J. C. Conner, formerly senior sales engineer.

NGAA Service Medal to Crooks of Cities Service

Stanley B. Crooks of Bartlesville, Okla., superintendent of sales and traffic for Cities Service Oil Company's

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HOT FOOT

The Model SD Kinney pump has the high suction and rugged construction to unload or transfer high melting point, or low penetration asphalts at cooler temperatures than other rotary pumps.

This installation consists of a steam-jacketed Kinney Pump and Strainer connected to a jacketed piping system manufactured by the Parks-Cramer Co. of Fitchburg, Massachusetts. All piping, valves, and fittings are jacketed for steam or hot oil heating to eliminate plugged lines and to assure free pumping under all conditions.

For handling liquids hot or cold, choose a Kinney Model SD Pump to speed the job. There are over 40 models with displacements from 1½ GPM to 3,000 GPM, for working pressures from 70 to 250 psi, depending upon pump model and type of liquid. Send coupon for complete details. Kinney Manufacturing Division, Boston 30, Mass. Representatives in principal cities of the United States and foreign countries.

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. . . contains complete descriptions, specifications and illustrations of Tracerlab's nuclear instrument, radiochemical and laboratory accessory line . . . the largest and most comprehensive of any manufacturer in the nucleonic field. Included are the new Autoscaler, available in seven models; the Automatic Flow Counter; a newly redesigned Laboratory Monitor; several new Geiger-Mueller tubes, including the TGC-20 Well Geiger Counter; new sources; as well as many new chemicals and accessories. A unique section of this catalog describes such custom equipment as the Liquid Scintillation Detector, MEW Counter, Multichannel Analyzer, Argon Gammagraph, Robot Scaling Equipment with Robot Sample Changer, Facta Printer and Automatic Chromatogram Scanner, a Beta Ray Spectrometer, Four Pi Counter and special air monitors. If you haven't received a copy, please request one.

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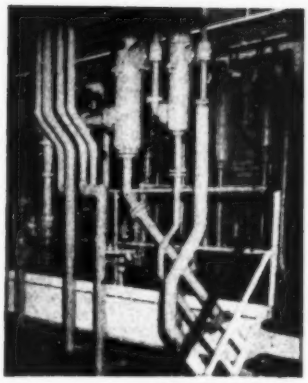

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Hoffmann-LaRoche, Inc., Nutley, N. J.

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This illustration shows two 4-stage Evactors in the plant of a leading manufacturer of vitamins and other pharmaceuticals. The same plant uses numerous other C-R Evactors of different types—as do the majority of manufacturers in this important field—for many different processes, including deodorizing, distilling, drying, refrigeration, etc. They are as simple as the valves that turn them on, yet maintain absolute pressures down to a small fraction of 1 m.m. absolute where steady, dependable vacuum is extremely important.

This steady, dependable vacuum is contributing to the improved health of our population by helping to supply purer and more potent vitamins, antibiotics and other pharmaceutical products. It is contributing indirectly to the health of many operators and executives in other manufacturing industries, by minimizing worry over vacuum problems. This also applies to Jet Mixers, Jet Heaters, Jet Absorbers, Jet Scrubbers, Jet Pumps, Jet Condensers and Barometric Condensers.

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What's Happening. . .

Gasoline-Chemical division, is the recipient of the Distinguished Service Medal of the Natural Gasoline Association of America. The medal recognizes Crooks' 33 years as charter member of the association and his contributions to the industry in the field of committee work in traffic, technical and statistical studies.

Industrial Medics Elect Davis President-Elect

Dr. Kieffer Davis, medical director, Phillips Petroleum Company, was recently elected president-elect of the Industrial Medical Association. Davis, previously first vice president, will serve one year as president-elect before becoming president.

Davis

Davis joined Phillips January 1, 1947 as head of the company's Medical department. He inaugurated a program of industrial medicine which now includes preventive and constructive as well as curative practices and was among the first in industry to use a mobile medical unit.

The Industrial Medical Association is a world-wide organization of physicians primarily interested in health and medical problems related to industry.

Mathieson-Olin Merger Seems Likely This Month

Merger of Mathieson Chemical Corporation and Olin Industries, Inc., looks like a certainty. The boards of directors of the two companies have voted unanimously to submit a merger proposal to stockholders of the companies this month and it should be accepted without a hitch.

Name of the new company will be Olin Mathieson Chemical Corporation. John Olin, president of Olin Industries, will become chairman of the board of the new firm, and Thomas S. Nichols, president and chairman of Mathieson, will become president. John W. Hanes will become chairman of the finance committee of Olin Mathieson.

1952 LPG Sales More Than Double 1947 Sales

Sales of liquefied petroleum gases—butane, propane, and butane-propane mixtures—more than doubled between 1947 and 1952, the Bureau of Mines has reported.

Humble Baytown Employes Set New Safety Record

Over 500 employees of the laboratories of Humble Oil & Refining Company's Baytown Refinery and members of their families recently celebrated the setting of an all-time safety record. Two "family parties," to permit those on duty to attend, were held to mark completion of seven years and more than

Enclosing covers on Overload Relays screwed on . . . give quick access.

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Interrupting Capacity
MOTOR STARTERS

OUTSTANDING ADVANTAGES

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Petroleum engineers specify these starters for Division 2 semi-hazardous locations because they assure substantial savings in installation and operation.

Construction advantages include: drip-proof roof . . . tank-cover and front cubicle doors . . . oil switch which opens 220-volt control transformer before upper door can be opened to operate main line disconnects . . . hermetically sealed control circuit contacts . . . main contactor with alloy contacts oil-immersed in rear tank. On voltage dips, push button circuit maintained up to 2 seconds by simple 3-wire circuit, permits opening of "stop" circuit without delay.

EC&M 2200-5000 volt Starters are also available in Division 1 style for Class 1, Group D Hazardous Locations. For interrupting capacities above 50,000 KVA, EC&M VALIMITOR (volt-ampere-limitor) Starters are furnished in both Division 1 and Division 2 construction.

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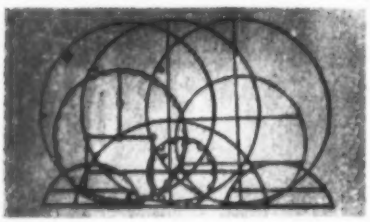

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What's Happening. . .

6,933,000 man hours without disabling injury.

Gulf Oil Appoints Craig Washington Representative

Lucien F. Craig has been named Washington, D. C., representative for Gulf Oil Corporation. He will be a member of the company's executive department, reporting to Vice President R. M. Bartlett.

Craig

Craig has been associated with Gulf for nearly 20 years. Having spent two years in the capital associated with the Petroleum Administration for War during World War II, he has considerable experience with Washington procedures. He will serve all departments of Gulf as requested by various officers.

Howard Will Head New Socony-Vacuum Division

Organization of an Analysis and Planning division to handle budgets, forecasts and related matters pertaining to manufacturing has been announced by Socony-Vacuum Oil Company, Inc. The new group will function as a division of the headquarters Manufacturing department and will be under the direction of Wayne A. Howard, formerly secretary of the company's manufacturing committee.

Howard will be succeeded in his former post by Kenneth W. Reinhardt, who, in addition to his duties as secretary of the manufacturing committee, will continue as coordinator of the department's personnel development activities.

Three Get Advancements At Esso Standard Oil

Esso Standard Oil Company has announced the election of Robert H. Scholl, formerly general counsel, to vice president, director and member of the executive committee. He will be succeeded in his former post by Einar B. Paust, associate general counsel since 1951.

Harold G. Mangelsdorf, general manager of manufacturing since 1953, has been elected a director.

Humble Resumes Tours Through Baytown Refinery

For the first time since the Korean conflict, Humble Oil and Refining Company has opened its Baytown, Texas, refinery for public tours.

Visitors are now able to see the plant, largest in Texas, on free guided tours each Friday afternoon. Humble provides trained guides to explain the plant's operation and special buses to transport the visitors through the refinery. In addition to the regular tours, special group tours may be arranged.

Sioux Gets Refinery From Cooperative Association

Sioux Oil Company has acquired the Cooperative Refinery Association's refinery at Newcastle, Wyo., for an undisclosed price. The sale included all property at the Newcastle refinery, including plant, machinery, equipment, inventory and supplies on hand as of February 1, 1954, when Sioux Oil was to commence its operation of the refinery.

With this acquisition, Sioux's refining capacity has been increased to handle 5000 barrels of crude oil a day: 2500 barrels at the present Newcastle plant; 500 barrels at the Chadron, Nebr., plant; and 2000 barrels at the new acquisition.

Virgil M. Yost, formerly with Bay Petroleum Corporation, Denver, Colo., has been elected a vice president of Sioux Oil to assist in the general management of the company's affairs.

Indiana Standard Names Natural Gasoline Men

Two well known personalities in the natural gasoline industry have been named to head a new Standard Oil Company (Indiana) Standard subsidiary to sell liquefied petroleum gas on a national basis. They are Ray A. Carter, formerly sales superintendent of Stanolind Oil and Gas Company, and Harry R. Thomas, who has been Stanolind's LPG sales superintendent.

The company they will head is Tuloma Gas Products Company, Carter as president and Thomas as vice president and general manager. Tuloma will take over the LPG sales of Standard and Stanolind, Standard's principal oil producing subsidiary.

All personnel of the new firm are transferring from Stanolind. Other principals in the new firm: William R. Thorne, manager of sales; K. V. Doughty, manager of supply; C. H. Browning, treasurer; R. A. McIntyre, secretary and attorney, and J. D. Thomas, comptroller.

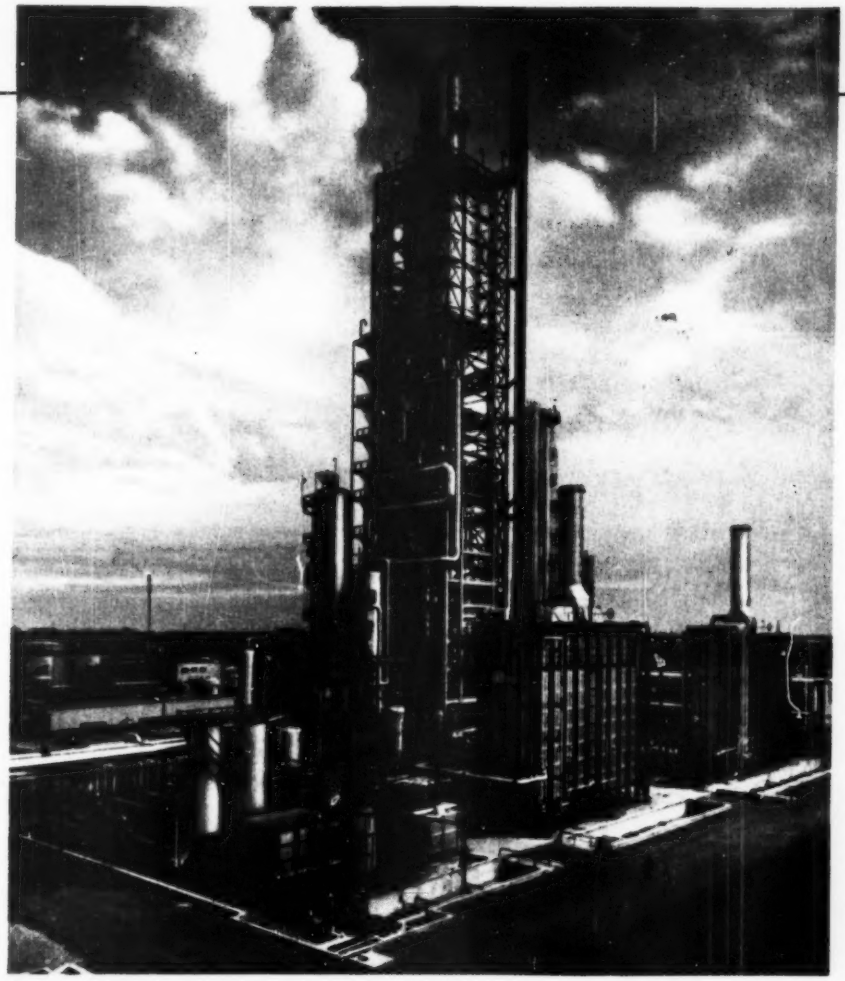
Shell Chemical Transfers Boutte to New Norco Plant

C. P. Boutte, chief engineer at Shell Chemical Corporation's Ventura, Calif., plant since 1952, has been appointed chief engineer at Shell Chemical's new chemical plant now under construction at Norco, La. He will serve as construction superintendent during current construction at the Norco plant, which is expected to be completed early in 1955.

In this latter capacity he will succeed R. K. Walters, who has been appointed assistant manager of the Manufacturing-Engineering department at the company's head office in New York. Boutte joined Shell in 1929.

Pierce Marion to Retire At Tide Water Associated

After more than 36 years of service with Tide Water Associated Oil Company, Pierce Marion will retire this month. He holds the posts of secretary to the Eastern division operating committee and assistant to the vice presi-



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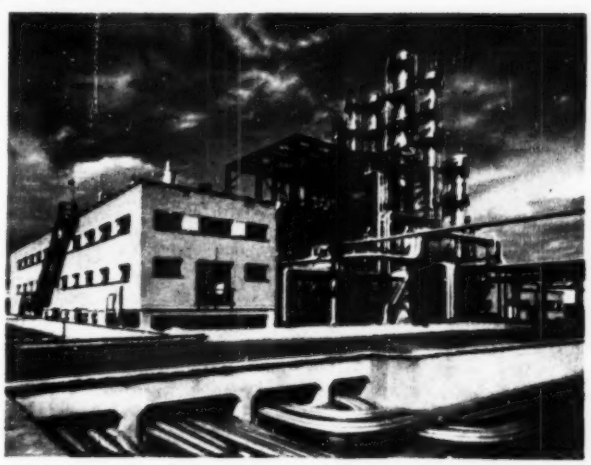

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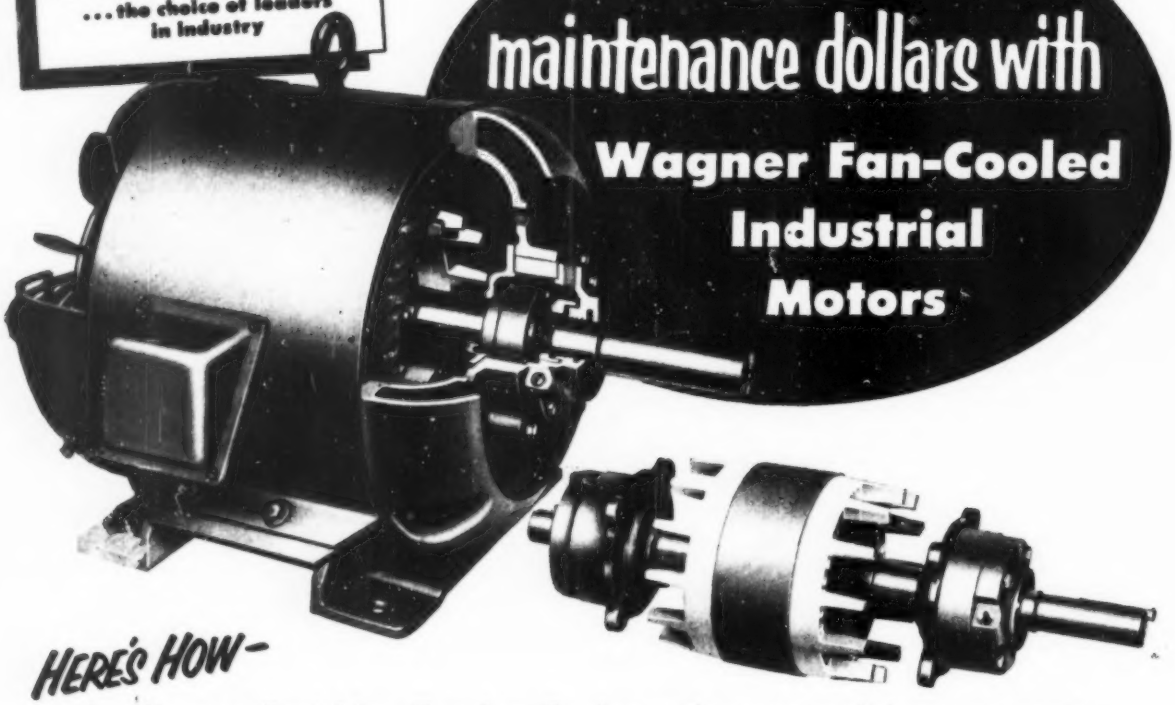

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Bearings are protected at all times. The Wagner design completely encloses the bearings in a sealed cartridge. Labyrinth seals prevent the entrance of water, dirt and other foreign material. Even when the motor is disassembled, the cartridge remains intact as part of the rotor shaft. The bearing housing stays completely enclosed for full protection against dirt and dust.

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Wagner Bearings run longer between grease periods. Hot bearings shorten grease life. Wagner bearings have a low temperature rise because the design incorporates a deflector shield that directs a cooling stream of air around the bearing housing. Bearings run cooler and longer between maintenance periods.

This cartridge bearing design is a feature of the entire Wagner line of totally-enclosed fan-cooled motors. The line includes standard and explosion-proof steel frame motors, and standard and explosion-proof cast iron frame motors. All types are available with normal torque or high torque characteristics, in ratings to 250 hp.

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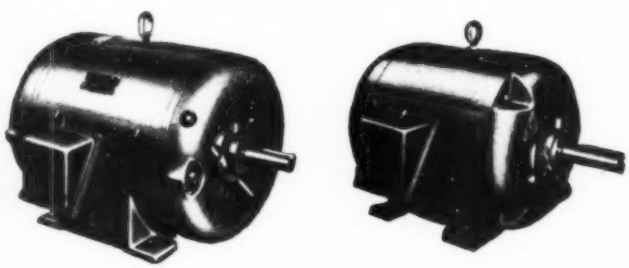

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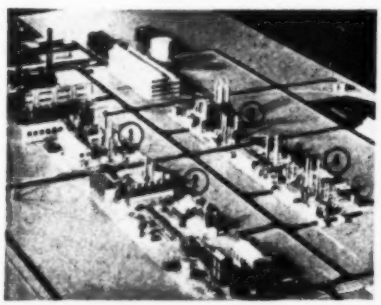
dent and chairman of the Eastern division operating committee.

Marion joined Tide Water as a clerk at the company's Bayonne, N. J., refinery in 1918.



Synthesis Unit Progressing—

Part of a scale model of the gasoline-from-coal synthesis plant now under construction in South Africa shows the principal units of the approximately $85 million project: (1) gasification plant; (2) reforming and gas purification plants; (3) Synthol plant, and (4) hydrocarbon recovery, catalytic polymerization and chemicals recovery sections. The plant, located at Coalbrook, about 50 miles from Johannesburg, covers about 5000 acres, and is being built for SASOL, South African Coal, Oil and Gas Corporation. The M. W. Kellogg Company designed and engineered many of the individual process units involved, and its subsidiary, Kellogg International Corporation, is in charge of procurement and construction. The plant is now about 60 percent complete.

Cyanamid Sets Up Scholarship Program

An undergraduate scholarship program in chemistry and chemical engineering has been established by American Cyanamid Company as a supplement to its existing post graduate fellowships and grants.

Under the new program 17 undergraduates about to enter their junior or senior year will be awarded $600 each for the academic year 1954-55. In addition, each scholarship college will receive $300 for the unrestricted use of its chemistry or chemical engineering department.

Under the fellowship program, 15 graduate students in their final predoctoral year of study receive $1500 plus full tuition and laboratory fees. Their department of chemistry or chemical engineering receives $300 for unrestricted use.

Students receiving fellowships or scholarships under the two Cyanamid programs are selected by the appropriate university and college authorities.

$135,000 Fire Hits Rothschild Refinery

Fire which broke out last month at the Santa Fe Springs, Calif., refinery of Rothschild Oil Company caused as estimated $135,000 damage. Operation of the plant was interrupted only for a few days.

The blaze is reported to have destroyed nine 1000-barrel gasoline tanks, a rack, offices and laboratory, but did not affect process units.

Standard Foundation Votes $150,000 Aid to Colleges

Standard Oil Foundation, Inc., a nonprofit Indiana corporation financed by Standard Oil Company (Indiana), has voted to make available $150,000 for use this year in aiding privately financed four-year liberal arts colleges in 14 Midwest states.

The 14 states involved are Colorado, Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Montana, Nebraska, North Dakota, South Dakota, Wisconsin, and Wyoming. The funds are to be allocated among state associations of private colleges. The associations, in turn, would allot the funds to their member colleges according to their individual practices.

What's Happening. . .

Indiana Standard Gives Company Stock to Employes

Approximately 32,000 employees of Standard Oil Company (Indiana) and ten subsidiaries this year were given 52,122 shares of Standard stock, worth $4,289,641, as a gift. The employes received an average of about $135 worth of stock each at the weighted market price of $82.30 a share the day it was distributed.

The employes live in 24 states, the District of Columbia and Canada. The free stock resulted from their participa-

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tion in the fourth year of Standard's savings and stock bonus plan.

Gulf Includes Lab in Philadelphia Expansion

A new refinery technology laboratory and a new office building for refinery administrative personnel have been built at Gulf Oil Company's Philadelphia refinery as part of Gulf's $50 million expansion program there.

Both buildings were designed by Howell Lewis Shay and Associates, Architects and Engineers, of Philadelphia, and built by Baton Construction Corporation, also of Philadelphia. The office building affords 36,000 square feet of floor space in a three-story section bounded by two-story wings. The laboratory, a three-story structure, covers 39,000 square feet.

The new laboratory operates as a separate division of the manufacturing department of Gulf, and provides control and testing services for all of the company's refineries.

Government-Industry Group Will Discuss Oil Shale

Bureau of Mines officials and industry representatives are scheduled to discuss oil shale problems and the government's role in that field at a meeting at Laramie, Wyo., August 10-11.

A number of oil company officials are expected to be on hand at the two-day meeting when the government's research works at Laramie and Rifle, Colo., oil shale plants are discussed, as several oil companies have expressed interest in commercial development in oil shale.

The Bureau's oil shale specialists will meet August 9, prior to going into the government-industry discussions.

Sinclair Elects Stone

Sinclair Oil Corporation has announced the election of Millard E. Stone, director of industrial relations for Sinclair and its subsidiaries, to vice president of the parent company.

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Tennessee Production Adds Gas-Gasoline Supervisor

Kenneth G. Pearce has joined Tennessee Production Company as gas-gasoline superintendent.

Pearce

Pearce was formerly with McKamie Gas Cleaning Company of Magnolia, Ark., as assistant manager. Prior to that he had been in Venezuela as district supervisor of gasoline for Creole Petroleum Company.

A native of Montana, Pearce began his career with Carter Oil Company, working in the design, construction and operation of gasoline plants. He was a U. S. Navy officer during World War II.

Chemical Industry Sets Safety Record in 1953

The chemical industry had its safest year in 1953, according to a report issued by the Manufacturing Chemists' Association. The record shows that member companies participating in the 1953 program established a new low accident frequency rate of 3.69 per million man-hours worked. Some 174 plants of 22 chemical companies operated throughout 1953 without a single lost-time accident.

The 1953 frequency rate compares with the previous low of 4.10 in 1952. The frequency rate in 1946 was 7.65 per million man-hours worked.

What's Happening. . .

Socony-Vacuum Starts Olean Refinery Shutdown

For some time now the Olean, N. Y., refinery of Socony-Vacuum Oil Company, Inc., has been losing ground as a profitable operation. The old (opened in 1876) refinery has a capacity of 6500 barrels a day but recently has been processing only 2500 to 3000 barrels a day.

Socony-Vacuum recently took preliminary steps in a long-contemplated action—shutdown of the facility.

Reason for the company's decision to take action at this time is the approaching completion of its new refinery at Ferndale, Wash., which is presently being built for General Petroleum Corporation, Socony-Vacuum's affiliate on the West Coast. The company hopes that by dovetailing the closing at Olean with the opening at Ferndale, a substantial number of employes of the old refinery can be transferred to the new one.

Petrochemical Production Rises Sharply in 1953

Production of synthetic organic chemicals from petroleum and natural gas rose from 7.9 billion pounds in 1952 to

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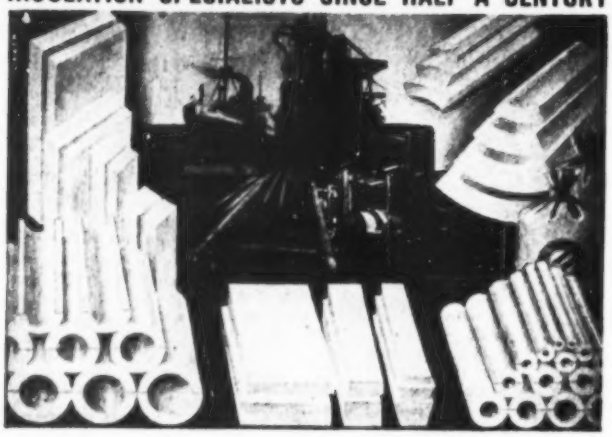

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What's Happening. . .

10.8 billion pounds in 1953, an increase of 38 percent, the Tariff Commission has reported.

Stanvac Makes Changes in Subsidiaries Personnel

Bryant F. Kenney, chairman and managing director of one of Standard-Vacuum Oil Company's South African subsidiaries, has been elected to the board of the parent company in New York. His election followed a ceremony held last month to mark the official opening of Stanvac's new $25 million refinery at Durban, South Africa.

Three other executive changes also announced at the Durban ceremony:

Joseph B. Nolan, of Capetown, has been named shareholder's representative in the Union and will coordinate the activities of all Stanvac interests in that country. In this capacity he will also be chairman of the board of Stanvac's marketing affiliate, Vacuum Oil Company of South Africa (Pty.) Ltd., and of Standard-Vacuum Refining Company of South Africa (Pty.) Ltd., whose plant was dedicated.

Charles E. Solomon, also a South African citizen, was chosen managing director of the marketing company, to succeed Nolan.

John B. Hanna, who has been supervising construction of the new Durban plant for the past two years, was named to succeed Kenney as managing director of the refining subsidiary.

Houdry Promotes Norris; Adds Ewbank to Patents

Eugene Norris, chemical engineer, has been promoted to commercial development engineer of Houdry Process Corporation, and John Ewbank, chemical patent attorney, has been added to Houdry's Patent department.

Formerly process engineer, Norris will, in his new post, provide technical assistance to licensees on all Houdry processes in addition to engaging in sales activities.

Ewbank was recently engaged in private law practice in Philadelphia. At Houdry he will be concerned with the prosecution of patent applications and related work.

Phillips Shifts Coffman To New Engineering Post

I. L. Coffman, chief engineer of Phillips Petroleum Company's Refining department, has been transferred to McGregor, Texas, as manager of engineering at Air Force Plant No. 66. This plant is operated by the Rocket Fuels division of the Phillips' Research and Development department. L. G. Molique, assistant superintendent of Phillips' Kansas City, Kan., refinery will replace Coffman, and will headquarter at Bartlesville, Okla.

National Constructors Announce Safety Awards

The National Constructors Association has announced awards to seven engineering and construction companies

What's Happening. . .

for outstanding safety records in 1953.

The companies: The Chemical Construction Company, New York; The M. W. Kellogg Company, New York; The Fluor Corporation, Ltd., Inc., Los Angeles; Ford, Bacon & Davis Construction Corporation, Monroe, La.; The H. K. Ferguson Company, Cleveland; J. F. Pritchard & Company, Kansas City, and Rust Engineering Company, Pittsburgh.

Caltex Elects Ernst

California Texas Oil Company has announced the election of A. E. Ernst, formerly assistant to the board chairman, to vice president.

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19 SOD Process Units To Be or Have Been Built

Nineteen units of Standard Oil Development's recently perfected refining process known as Hydrofining are either to be built or already have been installed in the U. S., England, France, Germany and Canada.

A wide variety of products, from gasoline to waxes, will be upgraded in these units. All of them are for affiliates of Standard Oil Company (New Jersey), for which Standard Oil Development does research and engineering. SOD has announced that it will also make the process available to other companies in the industry under license.

Combined capacity of the 19 units will be 155,000 barrels a day. Three units in the U. S. and two in England are already in operation, with a total capacity of 28,000 barrels a day.

Wilson Succeeds Court as Shell Engineering Manager

J. G. Wilson, formerly chief engineer at Shell Oil Company's refinery at Wood River, Ill. has been appointed manager of the Manufacturing Engineering department at the company's head office in New York. He succeeds W. F. Court, retiring for reasons of health.

Wilson joined Shell in Mexico in 1933 as an assistant engineer. He became assistant department manager at New York in 1948 and chief engineer at Wood River in 1952.

Stockholders Okay Merger Of Davison and Grace

Stockholders of The Davison Chemical Corporation have approved merger of the company with W. R. Grace & Company, whose stockholders had previously voted their approval.

Davison will operate as Davison Chemical Company Division of W. R. Grace & Company. Headquarters of the division will be maintained in Baltimore.

The present board of directors of Davison will continue as members of an advisory board of the Davison division, and present officers of the company will continue in corresponding posts of the new division of Grace.

West Made Vice President

The Ohio Oil Company has elected H. H. West, secretary and a director of the company, a vice president.

General Petroleum Expert On Air Pollution Dies

Willis G. Green, senior chemical engineer for General Petroleum Corporation, died last month of a heart attack. He was 39. An expert on air and water pollution problems, he was chairman of General Petroleum's Air Pollution Problems Committee. He had been with the company since 1936.

Emmert G. Surber Dies

Emmert G. Surber, refinery superintendent of General Petroleum Corporation's Torrance, Calif., refinery, died last month at 56. He had been in refining work with General Petroleum for 31 years.

Problem

To produce more ammonia without excessive expansion of existing facilities.

Solution

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Who's Meeting . . .

AIChE at Springfield . . .

. . . **Don't** discount batch operations entirely even though the completely automatic plant is near at hand. As the industry has grown, the case for continuous operation has been enhanced but the batch process should still be sonsidered (Dr. A. Klinkenberg, de Battafsche Petroleum Maatschappij, The Hague).

. . . **Watch** out for trace materials existing as contaminants in flowstreams when designing or starting up a plant. They can be the source of a great deal of unanticipated trouble. Some to keep in mind for ammonia plants: catalyst "poisons," fly ash, sulfur in fuel, and argon gas in air (N. C. Updegraff, The Girdler Corporation, Louisville).

. . . **Design** of cracking reactors still presents a challenge. Though not too much is known about the chemistry of cracking, the elements of chemical kinetrics combined with present design techniques can yield the most logical procedure to commercial design (J. R. Fair and H. F. Rase, University of Texas, Austin).

. . . **Small** automatic laboratory distillation columns are becoming very popular. The latest described is a 2-inch glass column packed to a height of 78 inches with stainless steel protruded packing. Operating data shows good HETP, pressure drops and flooding rates (G. A. Latinen, Monsanto Chemical Company, Springfield).

. . . **"Operations** research" has become the new factor in a cost-minded management. Borrowing the methods used in pure chemical research, operations research is tracking down operating costs. Some of their broad problems: advertising budgets, bonus plans, inventory policies and manufacturing standards (J. F. Magee, Arthur D. Little, Inc., Boston).

. . . **Costs** can best be controlled in construction by means of accurate recordkeeping. Daily or weekly graphic charts showing actual versus estimated costs will enable a field project manager to take corrective actions (R. E. De Simone, Construction Consultant, New York).

. . . **Standards** are the secret to controlling costs in production. But these standards for raw materials, operating labor and supervision, supplies, maintenance material and labor and utilities require great care when they are set up (D. E. Pierce, Diamond Alkali Company, Cleveland, and W. I. McNeill, Management Consultant, New York).

. . . **Statistical** methods are a very valuable tool in controlling costs and setting up standards. They have a definite advantage over the one-at-time attack, since they take into account the whole problem for an extended period (L. A. Seder, Quality Control Consultant, Malden, Mass.).

. . . **As an** engineering material, the styrene-rubber blends, polyvinyl chloride, and Saran are getting the most interest. They are finding new applications in chemical plants as extruded pipe, molded fittings and valves, and thermal welded laminated sheet (R. B. Seymour, The Atlas Mineral Products Company, Mertztown).

. . . **Hydraulic** gradients gave Dow abnormal trouble in 12 identical fractionating columns even though they were operated near design conditions. Sight glass windows proved that gradient was the trouble. Problem was solved in additional towers by using staged caps for hydraulic gradient compensation (J. A. May, The Dow Chemical Company, Freeport and J. C. Frank, Dow Chemical, Midland).

Pollution Conference at Pittsburgh . . .

. . . **Air** pollution is being attacked vigorously at the state level in Washington state. Though recognizing that the problem is a local one, the costs of research are prohibitive to many small industries. The Washington plan includes director of the commission, environmental research laboratory, voluntary civic committee, and an advisory service (R. N. Kusian, University of Washington).

. . . **The Atlantic** Refining Company at Philadelphia has really gone formal on its pollution problems. The "Air Pollution Abatement Committee" is represented by the Refinery division, Lube Oils division, Chemicals division and Steam division as well as the Medical department, Research and Development and a working group called Waste Control. Results have been very satisfactory from the standpoint of the few complaints now received (W. B. Hart, Atlantic Refining, Philadelphia).

. . . **Odor** abatement is in for more consideration now that methods are available for eliminating them even though they aren't injurious to health. The two principal methods are the use of masking agents and odor reactants (W. A. Quebedeaux, Houston).

. . . **It now** looks like the unpleasant effects of Los Angeles smog are due to reactions which occur between gaseous

Original Presentation Was Before CNGA

The acknowledgment in the two articles by V. O. Bowles and G. C. Thrift appearing in the May issue of the PETROLEUM REFINER should have read as follows:

"Original presentation was before the California Natural Gasoline Association Meeting, January 7, 1954 at Los Angeles. A more recent presentation was made before the Natural Gasoline Association of America's 33rd Annual Meeting at Dallas on April 23, 1954."

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AT NO ADDITIONAL COST

- Made from heat-treated bars — (A.S.T.M. A193 Grade B-7)
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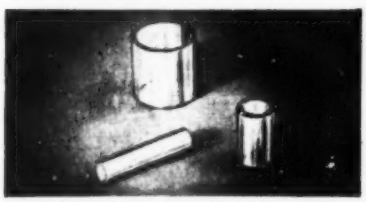

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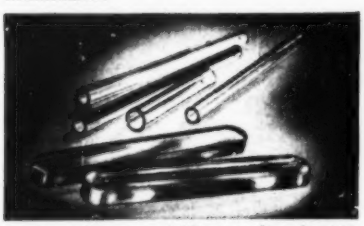

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Who's Meeting . . .

impurities *after* they are released to the air. The facts indicate the photochemical formation of ozone or oxidant from impurities by the action of sunlight (Morris Katz, Defense Research Chemical Laboratories, Ottawa, Canada).

. . . **There's** been a rash of new equipment to aid pollution studies, too. For sampling, there's an automatic impinger, a thermal precipitation device, and an automatic filter paper sampler. Also there have been improvements made in impingement baffle scrubbers for cleaning and absorbing gases.

Refining Division Sets New Registration Record

A new all-time high in registration at American Petroleum Institute refining meetings was set last month at the 19th mid-year meeting of the Division of Refining held in Houston. On the final day of the four-day meeting, registration soared to 1890. Previous record for API refining meetings was 1163, set in New York last May.

The 20th mid-year meeting of the division will be held in St. Louis, Mo., May 9-12, inclusive, 1955.

Famed Chemist Will Visit U. S. This Fall to Speak

Dr. Walter J. Reppe, one of the world's most respected chemists, will come to the U. S. from West Germany this fall as visiting professor of chemistry at Carnegie Institute of Technology under a grant from Koppers Company, Inc., Pittsburgh.

Dr. Reppe, vice president and director of I. G. Garbenindustrie A. G., since 1939, will stay in the U. S. for six weeks, lecturing at Carnegie and several other important chemical centers. He is to arrive in October.

CHEMICALS WANTED

The National Registry of Rare Chemicals, Armour Research Foundation, 33rd, Federal and Dearborn Streets, Chicago 16, has received urgent requests for the chemicals listed below. If anyone has one or more, even if only one gram quantities, please inform the Registry.

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Isolaurylamine
4-Hydroxyphthalic acid
Quinquephenyl
Isobutylene oxide
9-Decenoic acid
Butadiene monoxide
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Who's Meeting . . .

IN THE FUTURE

JUNE 6-11	Society of Automotive Engineers (Summer Meeting), Ambassador and Ritz-Carlton Hotels, Atlantic City, N.J.
9-11	Oil Industry Information Committee, Edgewater Beach Hotel, Chicago.
13-18	American Society for Testing Materials (Annual Meeting and Exhibits), Sherman Hotel, Chicago.
21-25 (tentative)	American Institute of Electrical Engineers (Combined Summer and Pacific Meeting), San Francisco.
24-25	Western Petroleum Refiners Association (Regional Meeting), Leonard Refineries, Inc., Auditorium, Alma, Michigan.
27 to July 1	Petroleum Equipment Suppliers Association, Manoir Richelieu, Murray Bay, Quebec, Canada.
AUG. 23-25	Appalachian Gas Measurement Short Course (14th Annual Session), West Virginia University, Morgantown, W. Va.
SEPT. 8-10	Oil Industry Information Committee, Conrad Hilton Hotel, Chicago.
12-16	American Institute of Chemical Engineers, Hotel Colorado, Glenwood Springs, Colo.
12-17	American Chemical Society, New York.
15-17	National Petroleum Association (52nd Annual Meeting), Traymore Hotel, Atlantic City, N.J.
23-24	Western Petroleum Refiners Association (Regional Meeting), Henning Hotel, Casper, Wyo.
27-29	American Institute of Electrical Engineers (Joint Meeting with Tulsa Engineers Club), Mayo Hotel, Tulsa.
27-30	American Society of Mechanical Engineers (Petroleum Division), Statler Hotel, Los Angeles.
OCT. 7-8	California Natural Gasoline Association (29th Annual Fall Meeting), Ambassador Hotel, Los Angeles.
18-22	National Safety Council, Chicago.
21-22	Western Petroleum Refiners Association (Regional Meeting), Garrett Hotel, El Dorado, Ark.
25-29 (tentative)	American Institute of Electrical Engineers (Fall General Meeting), Chicago.
NOV. 4- 5	Society of Automotive Engineers (National Fuels and Lubricants Meeting), Mayo Hotel, Tulsa, Okla.
8-11	American Petroleum Institute (34th Annual Meeting), Conrad Hilton Hotel and Palmer House, Chicago.
15-17	American Standards Association (Annual Meeting), Roosevelt Hotel, New York.
28 to Dec. 3	American Society of Mechanical Engineers, Statler Hotel, New York.
Dec. 8-10	Oil Industry Information Committee, Waldorf-Astoria, New York.
12-15	American Institute of Chemical Engineers (Annual Meeting), Statler Hotel, New York.

OIIC Honors Hardwick at API Marketing Meeting

C. Z. Hardwick, executive vice president of The Ohio Oil Company, has been honored for his work with the Oil Industry Information Committee, the public relations branch of API.

Hardwick was presented a "certificate of appreciation" at the recent mid-year meeting of API's Division of Marketing.

What Suppliers Are Doing . . .

Rockwell Division Assigns Johnson, Geuss to New Posts

Robert A. Johnson, Atlanta district sales manager of the Rockwell Manufacturing Company's Meter and Valve division, has been named New York district sales manager. George L. Geuss, a service engineer with Rockwell for the past 14 years, has been appointed assistant manager of the division's Nordstrom products.

Johnson

Johnson joined Rockwell in 1939 and was a sales engineer and assistant sales manager of liquefied petroleum gas products before moving to Atlanta.

Geuss will make his headquarters at the company's Homewood plant at Pittsburgh.

Babcock & Wilcox Names Five To Research and Development

The following appointments have been announced at the Research and Development Center of The Babcock & Wilcox Company, Alliance, Ohio:

P. R. Grossman to chief research engineer with responsibility for all work undertaken by the products, materials and technical sections of research and development, both at the center and in the field; A. F. Boehm, manager of facilities with responsibility for office management and maintenance; G. A. Watts to superintendent of products section; J. F. Wachunas to superintendent of the technical services section, and W. O. Stone, Jr., to purchasing agent of the center.

Beaird Company Holds Sales Meeting—

These sales representatives and sales engineers from the 48-state sales area of The J. B. Beaird Company, Inc., gathered in Shreveport, La., recently for the firm's annual spring sales meeting.

Attending, left to right: first row, seated—H. H. Cochran, Sodus, Mich.; J. W. Hendryx, Shreveport; Horace Thomasson, Bossier City, La.; S. L. Gordon, Los Angeles; Al Berg, Shreveport; John Birkos, Chicago; second row, seated—W. W. Sentell, Tulsa; E. G. Owens, Stockton, Calif.; B. N. Owens, Shreveport; L. W. Abbott, Montgomery, Ala.; Harold Graviss, Elizabethtown, Ky.; Dawson Lary, New Orleans; George Crozier, Shreveport; Vernon Burkhead, New York; Roy Hathorn, Shreveport; standing—J. L. Tullis, general manager of sales, Shreveport; Fred Hendrix, Atlanta, Ga.; Gerald Pope, Houston; J. F. Atkinson, Shreveport; W. F. Raynolds, Midland, Texas; Raymond Keller, Corpus Christi, Texas; Leo Johnson, McLeansboro, Ill.; Ty Adams, Shreveport; J. L. Riseden, Shreveport; George Gaston, Shreveport; Bill Gulledge, Portland, Ore.; C. Ray Elrod, Bossier City, La.; E. S. McRoberts, Shreveport; Warren Parish, Shreveport; Richard Meisenbach, Shreveport; Charles Haynes, Shreveport; George Borgeson, Shreveport; V. L. Stevens, Shreveport; Paul Akers, Dallas, Texas; Harry Gill, Shreveport; M. A. Finuf, Shreveport; Doug Winn, Luling, Texas; W. W. Marston, Shreveport; M. C. Phillips, Oklahoma City, Okla.; R. W. Rademacher, Shreveport; Ken Miller, Daytona Beach, Fla.; Rex Wheeler, Shreveport; Lee Rasmussen, Des Moines, Iowa; Jim Rigsby, Shreveport.

Foxboro To Build New Factory

Ground has been broken for The Foxboro Company's new branch factory to be erected at San Leandro, Calif. Scheduled for completion by August 15, the new 8400-square-foot building will more than double the production area of the present San Francisco shop.

Refinery Supply Group Elects Slate of Officers for 1954-55

James E. Hughes, Western Supply Company, Tulsa, has been elected chairman of the Refinery Supply and Service Group for 1954-55. K. P. Hurley, Ingersoll-Rand Company, Houston, was named co-chairman.

New executive members are William H. Barnes, Clark Bros. Company, H. Stuart Wood, American Cyanamid Company, of Tulsa, and E. L. Start, Foxboro Company, Dallas.

A. D. Fishbeck, Phillips Petroleum Company, Bartlesville, Okla., is arrangements chairman. He will be assisted by L. R. Lyon, Fluor Corporation, Tulsa, co-chairman.

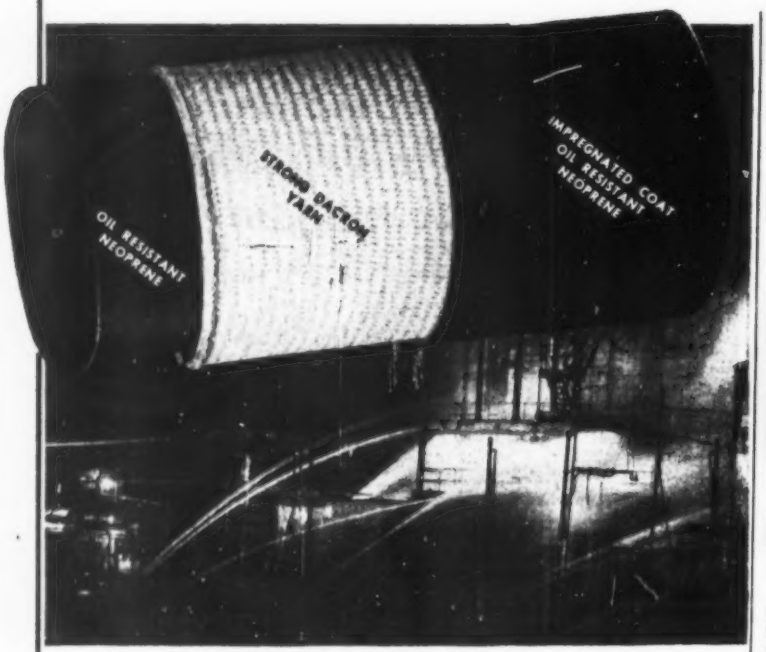
James Dvoracek, Black, Sivalls & Bryson, Inc., Tulsa, will be assisted by D. O. Givens, Refinery Engineering Company, Tulsa, in the handling of finances. Jack Rice, International Nickel Company, Houston, is housing chairman, and O. W. Stanley, Cooper-Bessemer Corporation, Houston, co-chairman.

Warner-Lewis Adds Representative—

Representatives of Warner-Lewis Company and Allan Edwards Company meet following the signing of an agreement in which Warner-Lewis named the latter company the Warner-Lewis representative in the Mid-Continent area. Allan Edwards Company offices are in Tulsa. Left to right are: T. R. Bradley, assistant sales manager, Warner-Lewis; D. W. Moss, J. F. Allison, D. B. Mathey, Allan J. Edwards, Jr., Allan Edwards Company; J. N. Fitzgerald, vice president, Warner-Lewis; Allan J. Edwards, president of Allan Edwards; J. D. Irons, Allan Edwards; M. A. Phillips, assistant sales manager, Warner-Lewis; and J. S. Osborn, Allan Edwards.

American Car and Foundry Will Purchase W-K-M Company

American Car and Foundry Company has contracted to purchase W-K-M Company of Houston. W-K-M, with a sales office in Los Angeles and an export office in New York, will operate as a wholly owned subsidiary of American Car and Foundry, and will continue



OIL RESISTANT
Inside and Out

Quaker

PETROCHEM FIRE HOSE

Weighs 50% less, yet takes 50% more pressure than conventional oil resistant, rubber covered fire hose! It is the first fire hose made exclusively for the oil industry. Neoprene tube. Jacket of Dacron yarn impregnated with black oil-proof Neoprene rubber. So flexible it can be tied in knots; easily coiled or folded for minimum storage space. So strong and abrasive-resistant you can use Quaker Petrochem fire hose under any refinery conditions for pressures up to 500 lbs.; temperatures up to 300° F.

Write for name of nearest distributor. . .

Belting, Hose, Packing and Moulded Rubber of every construction for every need.

QUAKER RUBBER CORPORATION
DIVISION OF H. K. PORTER COMPANY, INC.
OF PITTSBURGH
PHILADELPHIA 24, PA.
Branches in Principal Cities

Suppliers . . .

in Houston. Local management and personnel of W-K-M will continue as in the past.

Three Promoted in Expansion Of Shippers' Car Line Sales

American Car and Foundry Company has appointed Shippers' Car Line Corporation, a subsidiary, its exclusive sales

Krumech

Slater

representative for the sale of ACF-built tank cars and tank car parts. The appointment expands Shippers' service of leasing tank cars, covered hopper cars and other classes of freight cars.

At the same time Shippers' Sales department was expanded with the appointments of John P. Krumech as vice president in charge of sales, Robert S. Slater as vice president, and Edgar F. Whitmore, Jr., as assistant vice president.

Krumech has been a vice president of Shippers' since 1952 and previously was traffic manager of American Car and Foundry. Slater has been sales manager of ACF tank cars and pressure vessels since 1946. Whitmore was assistant to the vice president until his recent appointment.

Leeds & Northrup Will Build $4 Million Instrument Plant

Construction of a modern instrument plant on a 129-acre tract adjacent to North Wales, Pa., about 22 miles from Philadelphia, is planned by Leeds & Northrup Company. Estimated cost of the 250,000-square-foot building, additional equipment, and other essentials is in excess of $4 million.

Present schedules call for construction to start in the early fall, with occupancy in late 1955.

Foundrymen's Award Goes To Eagan of Cooper-Bessemer

Thomas E. Eagan, chief metallurgist of The Cooper-Bessemer Corporation, has been awarded the Joseph S. Seaman Gold Medal by the American Foundrymen's Society. The award was presented to Eagan for his "outstanding work in the development and dissemination of engineering data on the production and utilization of alloy cast irons."

Cameron Adds New Service

Cameron Iron Works, Houston, has announced it is now offering fabrication of high-pressure, thick-wall, forged steel pressure vessels and other heavy custom made equipment used in process industries.

For more data on advertised products, use Readers' Service Cards, last page.

Suppliers . . .

Pauly

Layritz

Lunkenheimer Advances Pauly And Layritz to Sales Posts

Melvin W. Pauly has become general manager of sales and Harold H. Layritz assistant general manager of sales at The Lunkenheimer Company. Pauly joined the company in 1950 as New York manager and later became sales manager, Eastern division. Layritz was previously sales manager of the Central division.

Dornsife Made Vice President Of California Steel Products

Appointment of Harold W. Dornsife as vice president and general manager of California Steel Products Company, Richmond, Calif., has been announced by American District Steam Company, recent purchasers of the former company.

Dornsife

Dornsife was project manager at C. F. Braun and Company for seven years before joining California Steel.

Previously he had been with Standard Oil Company of California for eight years.

Allied Chemical Division Changes Five at New York

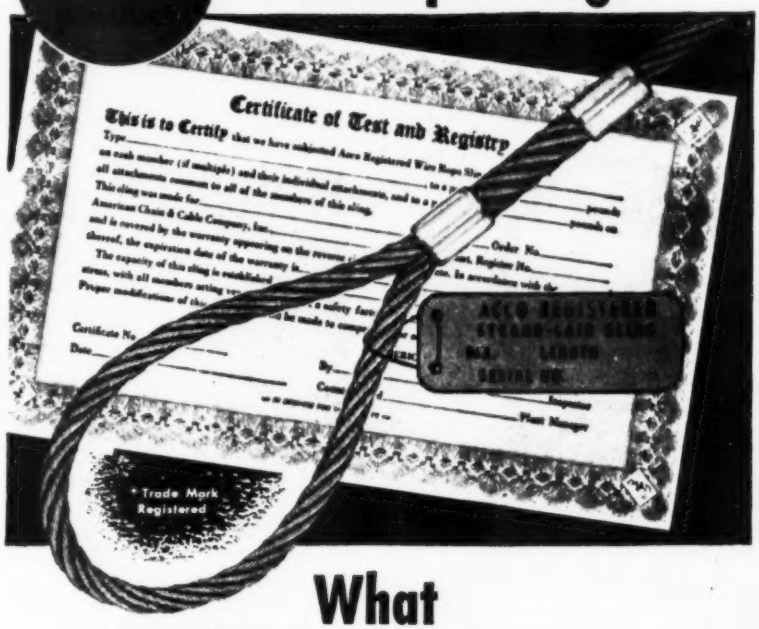
Five appointments in its New York executive office have been announced by the Solvay Process division of Allied Chemical & Dye Corporation.

Denman Peniston, formerly director of sales, is now assistant to the president and has been succeeded in his former post by John H. Elleman, formerly assistant director of sales. Now assistant directors of sales are Arthur Phillips, Jr., formerly assistant to the director of sales; Harry R. Stoothoff, formerly manager of Solvay's Special Alkalies and Cleansers section; and Neal M. Draper, formerly manager of Solvay's Ammonium and Potassium section.

Jenner Joins Micro Switch

R. R. (Dick) Jenner, formerly chief radio and electronics engineer for Beech Aircraft Company, has been appointed to the newly created post of director of airborne products for Micro Switch of Freeport, Ill., a division of Minneapolis-

ACCO Registered* Wire Rope Slings



What ACCO Registered Means

• Primarily it means greater safety for your men and machines when loads are carried in the air in your shop. It means insurance against dropping a load which could tie up production.

But that's only part of the story. The name ACCO *Registered* on the slings you use means greater efficiency because of better design of endings and attachments. It means lower overall sling costs because every part of every ACCO *Registered* Wire Rope Sling has the same strength as the catalog breaking strength of the rope itself. ACCO even magnafluxes each hook to make doubly sure it will serve you well.

And it means that the sling has been proof-tested at the factory to twice its rated capacity. You can be sure that every ACCO *Registered* Wire Rope Sling is the safest, strongest and lowest cost lifting tool you have ever used.

Best of all, you can get them when you need them from a nearby stock. Contact your ACCO *Registered* distributor today for full information and prices. Or, write our Wilkes-Barre, Pa., office.

1. The best material
2. Unit safety factor (on bodies, rings, links, safety shackles, hooks)
3. Proof test of complete sling to twice rated capacity
4. Actual field service test of each model
5. Metal identification tag on each sling
6. Signed Registry Certificate with each sling

ACCO

TRADE MARK

Wire Rope Sling Department
AMERICAN CHAIN & CABLE

Wilkes-Barre, Pa., Atlanta, Chicago, Denver, Houston, Los Angeles, New York, Odessa, Tex., Philadelphia, Pittsburgh, Portland, Ore., San Francisco, Bridgeport, Conn. ● In Canada: Dominion Chain Co., Ltd., Niagara Falls, Ont.

For more data on advertised products, use Readers' Service Cards, last page

PALMER
MERCURY ACTUATED

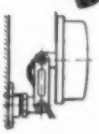
DIAL THERMOMETERS

in 3 types to suit any requirements

PATENTED

Full 4½" dial face. Stem can be placed at any angle and case can be rotated to any readable position.

1 Rigid Stem Dial Thermometer tapered bulb, interchangeable with standard industrial thermometer separable socket. (As illustrated above.)



2 Wall Mounted Dial Thermometer with flexible connecting armor. Case adjustable to easy reading position.

3 Flush Mounted Dial Thermometer for panel mounting with flexible connecting armor.

All three types have a full 4½" dial face.

for accuracy: Mercury actuated . . . Fully Compensated by Invar Compensator. Guaranteed Accurate 1 scale division.

for angularity: Can be adjusted to most readable position at any angle desired.

for readability: Bold Black Numbers . . . 11" of scale Reading Dial face can always be placed in easiest readable position.

for interchangeability: Always specify "PALMER" Separable sockets as they are interchangeable for Dial or Industrial type Thermometers.

WRITE FOR CATALOG INFORMATION

PALMER
THERMOMETERS, INC.
Norwood Ave. Cincinnati 12, Ohio
Mfrs. of Industrial Laboratory Recording and Dial Thermometers

Suppliers . . .

Honeywell Regulator Company. He will be directly responsible for the design and production of all Micro Switch products destined for use in the aircraft industry.

National Aluminate Appoints Braithwaite Vice President

Dr. David G. Braithwaite, formerly assistant vice president and production manager of the Catalyst division of National Aluminate Corporation, has been named a vice president. He will continue to head production activities of the Catalyst division in addition to assuming new management duties.

Braithwaite

Braithwaite began in National Aluminate's Ion Exchange division, rising to associate director of research before transferring to the Catalyst division. He was named assistant vice president in 1953.

Carbide and Carbon Chemicals Sets Up New Sales Division

A new sales division has been announced by Carbide and Carbon Chemicals Company, a division of Union Carbide and Carbon Corporation. Named the Southwestern division, it will include the states of Missouri, Arkansas, Louisiana, Texas, Oklahoma, Kansas, Colorado, Wyoming and Utah.

F. J. Rauscher, formerly district sales manager of the St. Louis sales office, has been appointed division sales manager of the new division. His headquarters will be in St. Louis.

The following appointments were also announced by the company:

H. L. Harwell has been appointed district sales manager of the St. Louis district; J. W. Ross has been appointed district sales manager of the Pittsburgh district; J. R. Hulten has been appointed district sales manager of the Philadelphia district, and J. F. Luther has been appointed district sales manager of the Albany district.

Thompson Succeeds Allen In Executive Post at Porter

W. Harvey Thompson has been named assistant to the executive vice president of H. K. Porter Company, Inc. Before joining Porter, Thompson was vice president of Standard Instrument Corporation of New York. He succeeds R. F. Allen, who has been elected a vice president in charge of Porter's Buffalo Steel division.

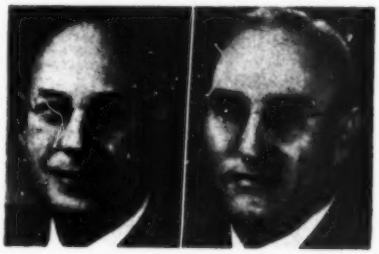
Annin Expands Facilities

Additional facilities for design and manufacture of automatic control valve equipment have been occupied by The Annin Company, Los Angeles.

The new plant will provide more than 30,000 square feet of engineering facilities for research and development of valves in the high pressure field.

Cooper-Bessemer Forms Three New Engineering Divisions

Three primary engineering divisions have been formed at The Cooper-Bessemer Corporation, and each will be directed by its own chief engineer.



Crooks Lay

Kuivinen

The new Development division will initiate new engine and compressor designs. Its chief engineer will be W. R. Crooks, who has been with the company since 1936.

The new Technical division will translate the new design ideas into practical machinery. Its chief engineer will be T. O. Kuivinen, who has held various engineering positions with the company for 25 years.

The new Product division will handle manufacture and application of Cooper-Bessemer equipment. Its chief engineer will be R. F. Lay, who has recently been in charge of stationary installation engineering at the company.

The new Cooper-Bessemer engineering organization plan will be headed by R. L. Boyer, vice president and chief engineer. The programs of the three divisions will be co-ordinated by E. Frederick, now executive engineer.

General Electric Holds Class On X-Ray Diffraction Units

More than 50 users of x-ray diffraction equipment attended the recent refresher course on the subject held at the Milwaukee, Wis., headquarters of General Electric Company's X-Ray department.

Chemicals, clays, metals and proteins all came in for discussion by leading experts in the field. Laboratory sessions in the afternoon alternated with class sessions in the morning.

Hamer Gets New Name

Hamer Oil Tool Company has changed its named to Hamer Valves, Inc. The company announced the change was made to identify the company more clearly with the product it manufactures.

Bailey Moves District Office

The Philadelphia district office of Bailey Meter Company, Cleveland, has been moved to larger quarters at 29 Bala Avenue, Bala Cynwyd, Pa. It is under the managership of H. C. Tanner.

Seminar Conferees Hear Dean Dunning—

A four-day seminar on "Frequency Response," sponsored by Taylor Instrument Companies recently at New York, was attended by this group of instrument engineers. Dr. John R. Dunning, dean of the School of Engineering at Columbia University, speaking at the seminar on the role of the engineer in the atomic age, predicted that in a short span of years atomic energy will replace many of the conventional sources of power.

The engineers, left to right: first row—Harold Kohlmeier, Polymer Corporation, Ltd.; John E. Carpenter, Carbide and Carbon; Thomas H. Pierson, Corn Products; L. D. Cipriano, Monsanto Chemical; Harold W. Crouch, Eastman Kodak Company; J. L. Corum, Proctor & Gamble; Warren Jackson, Standard Oil Company (Ohio); Alfred C. Schnell, Clark Brothers; L. Griffith, Canadian Chemical; second row—R. E. Fishlock, Linde Air Products; Jack Lynch, Ansco; Walter Bowers, Standard Oil (Ohio); Norman Koenig, Eastman Kodak; Bruce Powell, California Research; C. W. Blotz, National Aniline; Andrew Fowler, Carbide and Carbon; Edward Bartles, Eastman Kodak; Ralph Webb, Carbide and Carbon; Runne C. Ohrberg, M. W. Kelogg Company; third row—Henry Steinhauer, Goodyear Atomic Corporation; Eugene H. C. Brown, Industrial Engineering Corporation; E. I. Thomas, Carbide and Carbon; P. B. Nolan, National Petro Chemical; C. R. Otto, E. I. DuPont; A. Bremer, Shell Development Corporation; Lowell Zabel, Kimberly-Clark Corporation; Paul W. Joy, Carborundum Company; Marvin Gade, Kimberly-Clark Corporation; Ralph Kimball, American Viscose Corporation; John Johnston, Jr., E. I. DuPont.

France National Can Director

Mervin B. France, president of the Society for Savings in Cleveland, has been elected to the board of directors of National Can Corporation.

Inco of Canada Elects

Henry S. Wingate has been elected president of The International Nickel Company of Canada, Ltd., and F. M. A. Noblet has been elected treasurer.

Suppliers . . .

Nordberg Manufacturing Shifts Dutney to Presidential Aide

George V. Dutney has been appointed special assistant to the president at Nordberg Manufacturing Company. He will make his headquarters in New York.

Dutney

For the past 12 years Dutney has been on the Johns-Manville headquarters staff in New York as manager of sales to the steel, non-ferrous and special industries. He transferred to Nordberg last April and will represent the president in sales and special public relations throughout the country.

U. S. Steel Division Shifts Two Area Credit Managers

R. L. Cowan, Jr., formerly of the Mid-Continent Area credit office of United States Steel Corporation's Oil Well Supply Division, Tulsa, has been promoted to credit manager for the Canadian Area. He succeeds R. E. Mosely, who has been transferred to a similar post in "Oilwell's" California Area at Los Angeles.

At the same time the division announced that it has begun construction

for the Petroleum Industry

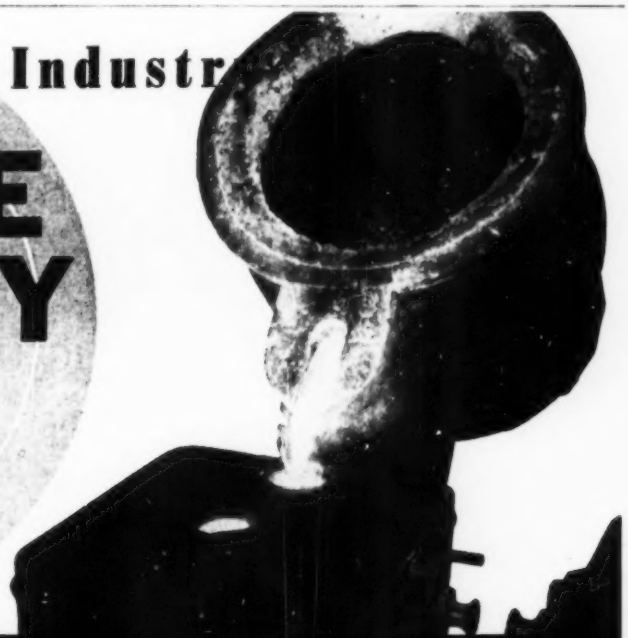
SERVICE FOUNDRY

top quality metallurgical control—

expert workmanship throughout, from

office force to delivery, has made

our name what it is today!



SERVICE FOUNDRY a division of AVONDALE MARINE WAYS, Inc.

416 Erato Street, New Orleans, U. S. A. P. O. Box 1030, New Orleans, U. S. A.

Cable Address: "Serfdry"

For more data on advertised products, use Readers' Service Cards, last page.

Suppliers . . .

of a new supply house at Houma, La., which will serve as a combination branch store and warehouse.

SAMA Elects Officers

Scientific Apparatus Makers Association recently reelected Edward J. Albert, president of Thwing-Albert Instrument Company, Philadelphia, president. T. M. Mints, president of E. H. Sargent & Company, Chicago, was reelected treasurer at the same time.

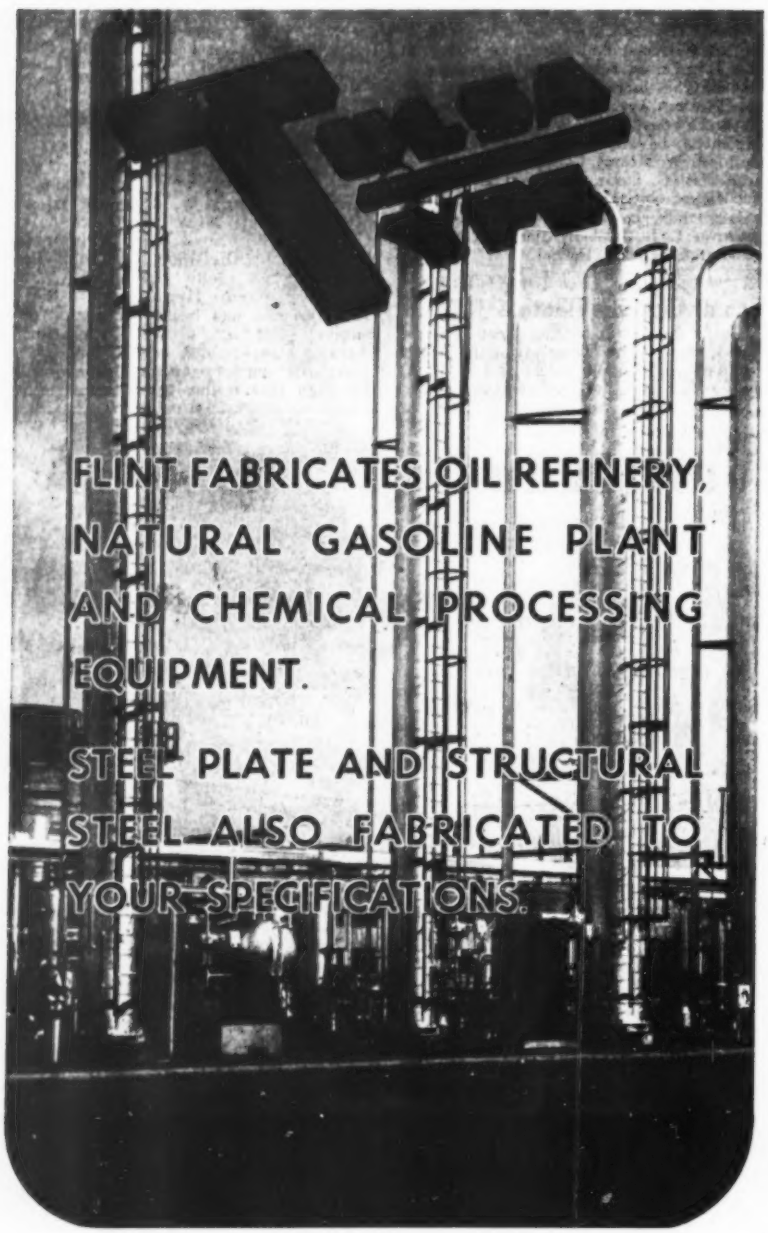
At SAMA's annual meeting held recently at Colorado Springs, Colo., chairmen of the association's six sections were elected and directors-at-large for the following year were named.

Curry Hecht and MacFarland Draw Celanese Promotions

Michael J. Curry has been elevated to director of the Application Laboratory of the Chemical division of Celanese Corporation of America, succeeding David D. Hecht, promoted to manager of the division's Product development department.

Curry will be in charge of the application research and technical service program assigned to the laboratory. Hecht will handle all market and customer relationship aspects of the development of new products.

In Celanese's Plastics division, J. J. McFarland, manager of the Product Development department, has been promoted to the new post of assistant to the general manager of the division.


FLINT FABRICATES OIL REFINERY, NATURAL GASOLINE PLANT AND CHEMICAL PROCESSING EQUIPMENT.
STEEL PLATE AND STRUCTURAL STEEL ALSO FABRICATED TO YOUR SPECIFICATIONS.

Beaird, Tullis and Johnson Receive Beaird Promotions

Three officers of The J. B. Beaird Company, Inc., of Shreveport, La., have

Johnson Tullis C. Beaird

been promoted. Charles T. Beaird was elevated to vice president, John L. Tullis to vice president and general manager of sales, and Melvin F. Johnson to secretary.

In addition to his new post, Charles T. Beaird is president and general manager of The J. B. Beaird Company, Inc., of California, a wholly owned subsidiary. Tullis, who for the past several years has been general manager of the Beaird organization, also serves as vice president in charge of sales for the California subsidiary. Johnson, prominent Shreveport attorney, has served as the company's general counsel for many years and succeeds Charles T. Beaird as secretary.

Other officers of the company, including J. Pat Beaird, president and general manager, were reelected.

B&W Will Study Equipment For AEC Power Development

The Babcock & Wilcox Company has signed an agreement with the U. S. Atomic Energy Commission to engage in studies related to the equipment aspects of nuclear power development. The company will make these studies independently of other work it is doing for the AEC or in association with other concerns in the AEC's industrial participation program.

Terms of the agreement point out that B&W "will make a survey and study of the commission's reactor development activities and determine the engineering, technical and economic aspects of practical applications of atomic power" and will "offer recommendations in a report to the Commission concerning such applications and industry's role in undertaking and carrying them out."

Universal Atlas Veteran Retires After 36-Year Service

After 36 years of service, Leroy (Roy) Carrier, general traffic manager of Universal Atlas Cement Company, subsidiary of United States Steel Corporation, has retired. He has been succeeded by John H. Dent, formerly assistant general traffic manager.

Amercoat Doubles Lab Space

Amercoat Corporation has moved into new executive offices and a new research laboratory recently erected at its home office site at South Gate, Calif. The new buildings have more than doubled the size of the firm's research and laboratory facilities.

For more data on advertised products, use Readers' Service Cards, last page.

Suppliers . . .

Hamer Adds Sales Agent

Fred W. Phillips, left, head of Fred W. Phillips Supply and Mfg. Company, Calgary, Alberta, Canada, and Leland "Shorty" Hamer pause after the former's company was appointed exclusive sales agent for Hamer Oil Tool Company valves in the Alberta Province.

Company Changes

A company's character usually remains the same but its face is constantly changing, either through additions of personnel or offices or through major reorganizations. These faces were recently in motion.

Dr. Bernard Rudner, formerly with General Aniline and Film Corporation, has joined the research and development staff of **The Davison Chemical Corporation,** at Davison's Hilltop Research Laboratories, Baltimore, Md. . . . **R. C. Angell,** recently in the Atlanta, Ga., office of **Worthington Corporation** as a merchandising salesman, has been appointed supervisor of Allspeed sales, at the firm's Oil City Works . . . **Dixon C. Van Winkle** has succeeded **L. G. Parkinson,** resigned, as manager of the New York district sales office of **Atlas Powder Company's** Chemicals department. Van Winkle joined the company in 1952 as a special sales assistant.

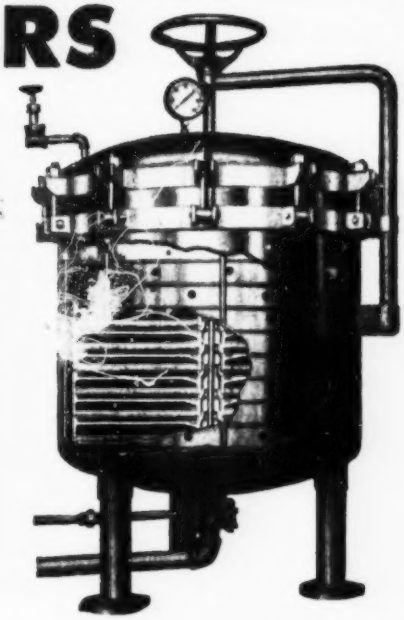
Charles C. Hornbostel, formerly president of National Company, Inc., has been appointed administrative assistant to the president of **Foster Wheeler Corporation** . . . **Wayne B. Morgan,** formerly of **Warren Petroleum Corporation's** Dri-Gas Corporation, has been named to the new post of assistant sales manager in charge of Warren's LP-Gas sales to refineries . . . **Elmer J. Weis,** formerly vice president and director of sales at **Pacific Pumps, Inc.,** has been elected executive vice president.

De Lavel Steam Turbine Company has appointed **Edward B. Coffey & Company,** Guatemala City, Guatemala, C. A., exclusive representative for De Laval products in the Republic of Guatemala.

Graver Water Conditioning Company has opened a Western European office under the direction of **Jorgen Berring,** European sales engineer, who will be located at Copenhagen, Denmark . . . **Larkin Packer Company, Inc.,** has opened a new Pacific Coast warehouse under the direction of **C. F. (Cliff) Warner,** in Los Angeles . . . **Marlow Pumps,** division of Bell & Gossett Company, has established a new branch manufacturing plant at Longview, Texas . . . **Rust-Oleum Corporation** has opened its new and enlarged plant facilities at

SPARKLER
HORIZONTAL PLATE
FILTERS

Noted for High Quality, Consistently Uniform, Fine Sharp Filtration of Petroleum Products . . . .



Many times Sparkler filters have been chosen by experienced filtration engineers in the petroleum field because of these specific features of superiority.

Sparkler filters deliver unusually high flow rates due to the horizontal plate construction that requires only a very thin precoat to produce fine sharp filtration right from the start. Less pressure is required with a thin precoat resulting in a filter cake of less density and high flow capacity. Intermittent operation or variation in pressures will not disturb the stability of the filter cake.

Any grade of filter paper, cloth, or screens, and any filter aid can be used with maximum efficiency because no pressure is required to hold the filter cake on the plate.

Frequently Sparkler filters are used in the petroleum industry with various grades of paper only without filter aid to perform a specific job that would be difficult or impossible with some other types of filters such as the removal of water from diesel lube oil or transformer oil.

A few typical applications of Sparkler Filters to the Petroleum and petro-chemical industries for the filtration of:

- Canned lubricating oil
- Methyl-Ethyl-ketone
- Polyisobutane
- Chlorinated hydro-carbons (carbon tet.)
- Aviation gasoline
- Jet engine fuel
- Hydraulic oil
- Gas engine & diesel lubricating oil (both continuous recirculation on the engine and batch-wise)
- Diesel fuel oil
- Cooling tower water
- Plant effluent water (to obviate stream and lake pollution)
- Removal of Raney nickel from alcohol streams
- Insecticides
- Caustics & acids
- Cottrell precipitator insulating oil (carbon black plants)

Sparkler horizontal plate filters are available in capacities from 30 to 30,000 G.P.H. depending on type of product filtered. Can be supplied in carbon steel, stainless steel, pure nickel, or monel, bronze, Hastelloy and Inconel. Rubber lined, brine or steam jacketed.

Sparkler representatives for personal engineering service are located in Dallas, Houston, San Francisco, and other principal cities. Western Branch, Los Angeles, California.

SPARKLER

Write Mr. Eric Anderson for your nearest Sparkler service representative.

MANUFACTURING COMPANY
MUNDELEIN, ILL.

Sparkler International, Ltd. Prinsengracht 876 Amsterdam, Holland

MAKERS OF INDUSTRIAL FILTERS FOR OVER A QUARTER OF A CENTURY

Suppliers . . .

Evanston, Ill. . . . **Dravo Corporation,** Machinery division, has opened a Southwest office in Houston under the direction of **George R. Beidler,** who will serve as district sales manager.

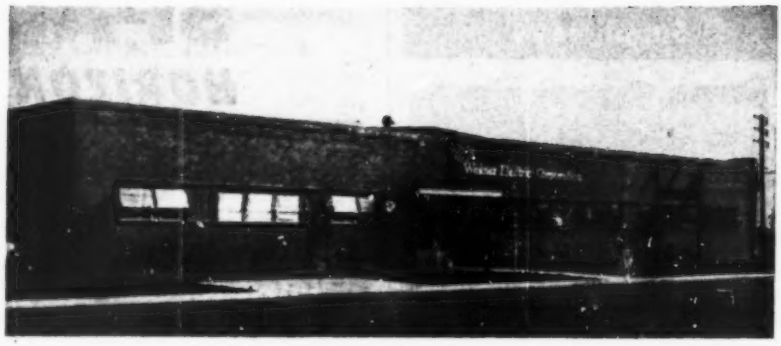
Tempil® Corporation has consolidated all its facilities, including office and shipping, at 132 West 22nd Street, New York . . . **Leeds & Northrup Company,** Philadelphia, has moved its Cleveland, Ohio, office to 1922 E. 107th Street . . . **Perkin-Elmer Corporation** has opened a sales office at Silver Spring, Md., under direction of **Edward A. Garlock.**

Babcock & Wilcox Elects W. J. Thomas Vice President

W. J. Thomas, general manager of the Tubular Products division of The Babcock & Wilcox Company, has been named a vice president . . .

Thomas

Thomas has been with B&W since 1932. He was associated with the Boiler division until 1941, when he left to join the Tubular Products division. He was appointed to the board of directors of the Tubular Products division in 1952, and general manager of the division last August.



Wagner Electric Opens New Los Angeles Office—

This new office and warehouse building of Wagner Electric Corporation will accommodate Wagner's automotive and electrical branch sales and service operations in Southern California, Arizona and New Mexico. Located at Los Angeles, the plant contains 22,500 square feet of floor space.

Kaiser Adds Cornforth

Robert M. Cornforth has been appointed manager of refinery sales for Kaiser Engineers division of Henry J. Kaiser Company, and will specialize in matters pertaining to the petroleum industry. He was formerly vice president in charge of sales for W. M. Barnes Company of Los Angeles and Toronto, Canada.

General Welding Elects Avis

Malcolm C. Avis has been elected vice president of General Welding Works, Inc., succeeding J. C. Nelson.

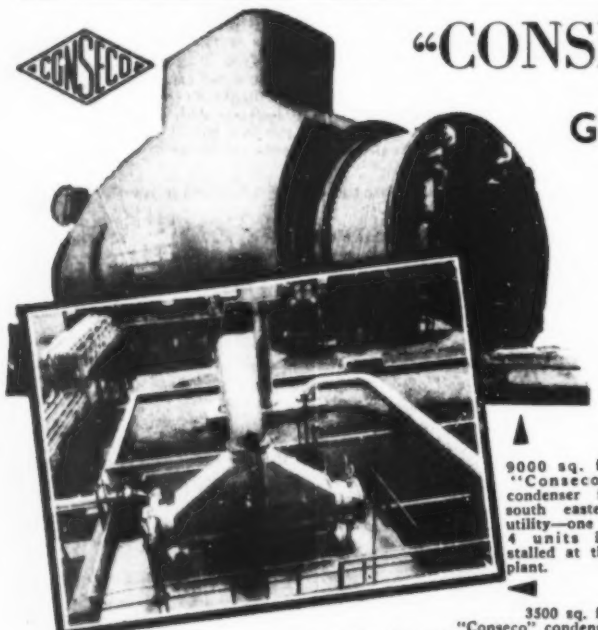
Stone & Webster Assigns Argue and Ryan to New Posts

F. W. Argue, assistant engineering manager of Stone & Webster Engineering Corporation, has been named engineering manager with headquarters in Boston.

W. F. Ryan, vice president, has been named senior consulting engineer of the corporation and placed in charge of its engineering report and appraisal activities.

Witco Transfers Two

James E. Cunningham, a member of Witco Chemical Company's technical



9000 sq. ft. "Conseco" condenser for south eastern utility—one of 4 units installed at this plant.

3500 sq. ft. "Conseco" condenser serving the turbine drive of the main air compressor in a southwestern refinery.

"CONSECO" CONDENSERS

GIVE SMOOTHER OPERATION LOWER MAINTENANCE

Hundreds of successful, trouble-free installations, ranging in capacity from the smallest to the largest, and including all types, have been designed, built, and installed for a long list of exacting industrial users in all parts of the world. Some "CONSECO" features are:

- deep water boxes
- wide tube spacing
- outside steam belt
- internal stiffening

For assured satisfaction—Call "Conseco."

WRITE FOR BULLETIN

CONSECO PRODUCTS

Retubing Condensers
Evaporators
Air Ejectors
Heat Exchangers
Flowrites
Tube Plugs
Conco Plugs and Guns
Bevel Gears
Instrument Repair Service
Blackburn-Smith Filters and Grease Extractors
Metal Spray
Bulletins Available for Above Items

Condenser Service & Engineering Co., Inc.

56 BLOOMFIELD STREET, HOBOKEN, N. J. HOBOKEN 3-4425—N. Y. TEL. BARCLAY 7-0600

MODERN EQUIPMENT and closest attention to every casting detail enable new Aloyco foundry to turn out the finest corrosion-resistant valve castings made.

New Aloyco foundry helps process industries in record expansion

PATTERN SHOP. In this well-equipped shop seasoned craftsmen make extremely accurate wood or metal patterns for valves of any size or complexity

During 1954, almost half the nation's total investment in new plants and equipment will go into the chemical and petroleum industries.

To meet their unprecedented needs for processing equipment, our new specially-equipped foundry will substantially increase the production of Aloyco corrosion-resistant valves.

For 25 years, Aloyco, the world's largest specialist in high alloy valves, has been helping the chemical process industries master valve corrosion problems. Alloy Steel Products Co., Inc., 1301 West Elizabeth Avenue, Linden, New Jersey.

Plants: Linden, N. J., Bloomfield, N. J., Elizabeth, N. J.

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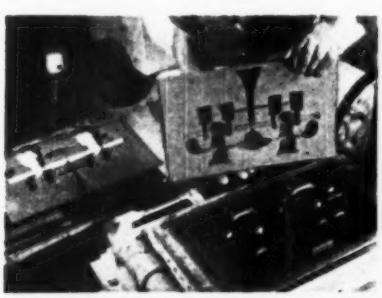
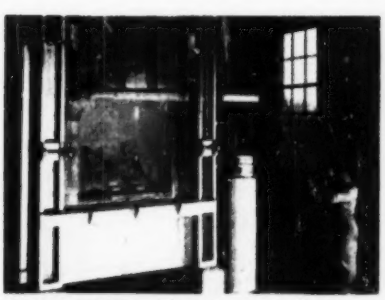


SHELL MOLDING. Up-to-date shell molding facilities assure users of the greatest contour accuracy in castings for small and medium-sized Aloyco valves.

INSPECTION AND HEAT STAMPING. Castings are carefully inspected, their "pedigrees" stamped in. Any not 100% perfect are remelted, never welded or patched



HEAT TREATING. After cleaning, all Aloyco austenitic type castings are heat treated and water quenched to insure maximum corrosion resistance.

How would YOU solve these two problems?

1. A PATCH AHEAD OF TIME, applied at the factory, reinforces the knees of dungarees and overalls. Patches are vulcanized under pressure with Radio Frequency Corp.'s high frequency, dielectric heater. If dielectric heat, generated in the material, is lost through conduction, vulcanization becomes inefficient. But Fenwal THERMOSWITCH® units in each platen minimize these losses by close temperature control. Vulcanizing 3000 patches per hour is now standard; 30 was.

2. DENTAL PLATE FIT STARTS WAY BACK. The tiny abrasive wheels for grinding and polishing dental plates must be very accurately molded of fine abrasive in a rubber base. The molds in which they're made must have delicate temperature control for consistent quality and uniformity. The manufacturer, The Wm. R. Hall & Son Co., uses THERMOSWITCH units in molds for accurate, reliable temperature control. Production figures can be kept high while rejects are low.

3. THIS IS IT — the Fenwal THERMOSWITCH control is simple — compact shell contracts or expands *instantly* with temperature changes, opening or closing electrical contacts. Adjustable and highly resistant to shock and vibration. Fenwal THERMOSWITCH units are solving temperature problems and helping to improve the final product throughout all industry.

4. SEND FOR THIS BROCHURE for complete explanation of the unique THERMOSWITCH unit. Also ask for more detailed, illustrated discussions of the problems above. Fenwal engineers will be glad to help you solve your temperature control problems involving heat, humidity, radiant heat, pressure and other variables. Write Fenwal Incorporated, 106 Pleasant St., Ashland, Massachusetts.

Fenwal

THERMOSWITCH®

Electric Temperature Control and Detection Devices

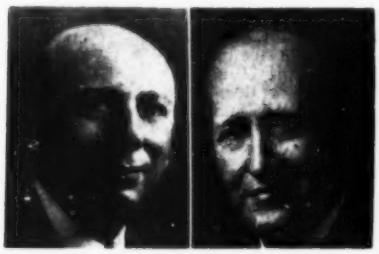
SENSITIVE... but only to heat

For more data on advertised products, use Readers' Service Cards, last page.

service staff, has been appointed to the New York sales staff, and Thomas F. Callahan, Witco salesman, is being transferred from the New York office to the Cleveland, Ohio, office.

Three Worthington Executives Assigned to Higher Positions

Three executives of Worthington Corporation have been appointed to new



Tullo Tribble

positions.

E. J. Tribble, former works manager of the Harrison, N. J., Works, has been named assistant vice president in charge of manufacturing with headquarters at the Harrison Works; A. M. Tullo, former works manager of Worthington's Wellsville, N. Y., Works, will assume responsibilities as works manager of the Harrison Works; and L. E. Hammer, former Wellsville assistant works manager, will take over Tullo's former post as Wellsville works manager.

Curran Becomes Director of Engineering at Hammel-Dahl

Hammel-Dahl Company has announced the promotion of John R. Curran to director of engineering.

Curran

During the past four years Curran has been chief design engineer of the Providence, R. I., firm.

Curran holds a B.S. degree in mechanical engineering from Northeastern University. At the time he joined Hammel-Dahl in 1945 as design engineer, he had several years experience in marine power plant operation and automatic control valve design.

Drake Becomes President Of New Pennsalt Division

William P. Drake has been named president of the new Industrial Chemicals division of Pennsylvania Salt Manufacturing Company. In this capacity he will be responsible for both the manufacture and sale of Pennsalt's line of industrial chemicals. He has been a vice president of the company since 1949.

Carter & Galantin Division Adds Bolduc as Sales Head

Edgar Bolduc, Jr., formerly factory representative for Autolite Company for five years, has been appointed sales manager of the Servicator division of Carter & Galantin, Chicago.

Three Vice Presidents Named In Promotions at Graver Tank

Graver Tank & Mfg. Company, Inc., has announced a number of promotions:

To vice president, Eastern sales—C. W. Springer, formerly Eastern sales manager; to vice president and general manager of the Mid-Continent division, directing the operation of the new Graver Supply Company—J. E. Fogarty; and to vice president and manager of the Rocky Mountain and West Coast divisions—W. T. Hudson, who will, in addition, direct operations at the new Graver plant at Fontana, Calif.

Hudson

Named as assistants to the president are J. W. Kiser, Jr., who will make his headquarters in New York; and J. W. Gosselin, whose offices will be in East Chicago.

Succeeding Springer as manager of Eastern Sales is H. J. D'Aragon. Promoted to assistant manager of sales of the Eastern division is L. J. Cogan.

Honeywell Promotes Smith to Manager of Regional Office

Claude Smith has been promoted from assistant manager to manager of the Dayton, Ohio, regional office of the Aeronautical division of Minneapolis-Honeywell Regulator Company. He succeeds Ray Condon, who recently was named to the newly created post of managed of military sales for the division. Smith joined Honeywell in 1943.

Ohio Steel Holds Meeting On Steel Casting at Lima

Plant construction engineers attending the recent steel casting conference at The Ohio Steel Foundry Company's Lima, Ohio, plant were introduced to modern casting procedures, design and the adaptability of casting to the process industry.

Talks highlighting the two-day conclave included: Foundry Practices and Requirements, Engineering and Design, and Pattern Planning. Open discussions were also held.

Wyatt Sets Up Foundation

A donation of $50,000 from Wyatt Metal & Boiler Works has enabled the creation of the W. J. Wyatt Foundation for public charitable purposes. Trustees of the foundation: Mrs. Annie Belle Leavell, daughter of the late W. J. Wyatt; Raleigh Hortenstine, president; George E. Gude, Jr., and Walter B. Van Wart, vice presidents, and Guy Gambrell, secretary.

American Locomotive Advances J. D. Vaughan and M. C. Downs

James D. Vaughan has been appointed a vice president of American Locomotive Company, and Malcolm C. Downs has been named comptroller. Prior to their new appointments, Vaughan had been comptroller and Downs assistant comptroller.

Suppliers . . .

Brown Spates

Pacific Pumps Appoints Two In Centrifugal Pump Division

W. E. Brown has been appointed Los Angeles district sales manager, Centrifugal Pump division, Pacific Pumps, Inc., and W. T. Spates has been appointed sales engineer. Brown has been a sales engineer with Pacific since 1951. Spates, with Pacific since 1929, has served in several engineering and manufacturing capacities.

Lukens Awards Contract For Armor Plate Finishing Unit

Brotherton Construction Co., Harrisburg, Pa., has been awarded the contract to complete the second major construction phase of the $10.5 million Navy armor plate finishing building and related facilities to be built on Lukens Steel Company property at Coatesville,

TEMPORARY STRAINERS

MAC-IRON

Established 1901

Made by a skilled mechanic and not by "just some guy with a torch."

REVOLUTIONARY CONSTRUCTION

Smooth, efficient contours . . . no weld "blob" around edge of ring. The flange is precision rabbeted into the ring joint gasket making deformation at that point impossible.

MAC-IRON offers a complete listing of line and temporary strainers. The latter of woven wire, perforated basket and conical . . . all for use with raised face, and ring joint flanges.

A large stock on hand is maintained; special strainers made to specification. Write direct for a catalog and complete information.

The Mack Iron Works Company

Warren and Water Sts. Sandusky, O.

For more data on advertised products, use Readers' Service Cards, last page.

FOR SALE
Seamless
Line Pipe

6,500 Feet
8⅝ O. D. 28.55#
1,400 Feet
10¾ O. D. 40.48#

Above items Grade A seamless, cleaned, straight, beveled: Approx. 40' DRL, excellent, like new condition. Priced low. Immediate shipment, Wilmington, Illinois.

WRITE, WIRE, PHONE
HUMBOLDT-CHICAGO PIPELINE PROJECT
125 W. 3rd St., Tulsa, Okla.
Phone 3-5400

Suppliers . . .

Pa. The contractors will begin work right away and have set a completion date of 11 months from the start of construction.

Ingalls to Be Represented In Houston by Harrison

Charles W. Harrison has been appointed district sales engineer in Houston for The Ingalls Iron Works Company and its subsidiaries, The Ingalls Shipbuilding Corporation and The Ingalls Steel Construction Company.

Harrison

Prior to joining the Ingalls organization, Harrison was the Houston representative for Parkersburg Rig and Reel Company.

Harrison will make his headquarters in the Melrose Building, Houston, where he will represent all the Ingalls companies.

Worthington Forms Subsidiary

Worthington Corporation has established a new subsidiary, Worthington Limitada, in Bogota, Colombia. It will be managed by Charles Gorham, who joined Worthington as an engineer in 1939 and has been in Colombia for five years.

Rockwell Transfers Luckett To Tulsa as Sales Manager

P. H. Luckett, a sales engineer with Rockwell Manufacturing Company's Macnick (Instrument) division in Tulsa, has been named sales manager for the division.

Luckett

Luckett, who has specialized in Rockwell oilfield integrator and orifice meter sales in the Houston district for the past two and a half years, will make his headquarters at Tulsa. He joined Rockwell in 1948 and spent two years at the Tulsa plant. He is a member of the Instrument Society of America, the Houston Engineers Club and the Houston Chapter of API.

Michael Brill Named to Head New Brill Equipment Office

Brill Equipment Company, for over 25 years equipment suppliers to the petrochemical and oil industries, has opened a new office in Houston. Michael Brill, formerly of the company's New York office, will direct the Houston office as general manager. The company, currently liquidating a substantial portion of the equipment of a large petrochemical plant in the Houston-Beaumont area, buys used equipment, sells reconditioned equipment and offers fabrication service at ASME shops.

Don't Let Boiler Scale

HOLD UP YOUR Power Plant Efficiency!
Ounces Only Once A Week
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Pure Colloidal Concentrate
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Fewer Shut-Downs
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Wellsville, New York

Refinery Engineer

One of this country's oldest technical publications, specialized for the refining and petrochemical industries, is seeking an addition to its staff. Applicant should have refining experience in maintenance and engineering design, and must have engineering degree. The following are most essential:

About four years experience in refining industry
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Like to read and write
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Although the man we seek will not necessarily do a great deal of writing himself, he will judge the writing of others. *This is a most unusual opportunity from the standpoint of salary and chance for promotion.*

Mail complete resume to Box 183-R, c/o Petroleum REFINER, Houston, Texas. Your application will be kept in strictest confidence.

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RATES: Regular Classified (undisplayed) set in this size type; 10 cents per word. Minimum charge, $3. Blind box address in our care counts six words. Replies forwarded without charge. **Display ads,** set in suitably larger type with ruled border, $10 per column inch.

All classified ads payable in advance. Ten percent discount for two or more insertions of same copy in consecutive issues. COPY DEADLINE: 25th of month preceding date of issue; Send copy and remittance to: Classified Ad Department, Petroleum Refiner, P. O. Box 2608, Houston, Texas.

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That Extra Equipment You Need

Cranes - Back Hoes - Draglines - Compressors & Air Tools - Pumps - Tractor & Wheel Mounted Cranes - Pipe Layers - Trenchers - Buckets - Dozers - Pile Hammers & Extractors - Payloaders and Tractor Mounted Front End Loaders - Hoists - Towers - Mixers - Welders - Portable Light Plants - Vibrators

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Practically new Petrochemical Equipment in Beaumont, Texas Area

TOWERS & COLUMNS

1—8' O.D. x 61' 6" stainless steel, 15 trays, design pressure 50#, design temperature 300°F.
1—7' 6" O.D. x 55'6" steel, 30 trays, design pressure 45#, design temperature 300°F.
1—7' I.D. x 42' steel, 20 trays, design pressure 40#, design temperature 150°F.
1—7' I.D. x 25' 6" stainless steel, 10 trays, design pressure 50#, design temperature 250°F.
1—7' O.D. x 5' O.D. x 70' 4½" steel, 35 trays, design pressure 64#, design temperature 300°F.
1—6' I.D. x 64' steel, 35 trays, design pressure 55#, design temperature 300°F.
1—6' I.D. x 45' stainless steel, 15 trays, design pressure 850#, design temperature 350°F.
1—5' O.D. x 61' 6" steel, 15 trays, design pressure 55#, design temperature 300°F.
1—4' O.D. x 110' 6" stainless steel, 70 trays, design pressure 75#, design temperature 300°F.
1—4' O.D. x 72' stainless steel, 40 trays, design pressure 55#, design temperature 300°F.
1—3' 6" I.D. x 63' steel, 35 trays, design pressure 55#, design temperature 250°F.
1—2' 6" I.D. x 60' steel, 35 trays, design pressure 55#, design temperature 300°F.
1—2' O.D. x 75' steel, 45 trays, design pressure 55#, design temperature 300°F.
1—2' I.D. x 73' steel, 50 trays, design pressure 70#, design temperature 300°F.

HEAT EXCHANGERS—CONDENSERS

2—1440 sq. ft., 304 S.S., 75# PSIG, 350°F.
3—1345 sq. ft. steel, 70# PSIG, 300°F.
1—1270 sq. ft. steel, 55# PSIG, 350°F.
2—1250 sq. ft. steel, 45# PSIG, 350°F.
2—1125 sq. ft. steel, 850# PSIG, 900°F.
2—1125 sq. ft., 304 S.S., 55# PSIG, 450°F.
1— 750 sq. ft. steel, 60# PSIG, 350°F.
1— 660 sq. ft. steel, 55# PSIG, 350°F.
1— 400 sq. ft. 304 S.S., 75# PSIG, 350°F.
1— 340 sq. ft. steel, 55# PSIG, 185°F.
1— 110 sq. ft. steel, 300# PSIG, 200°F.
1— 100 sq. ft. 304 S.S., 70# PSIG, 350°F.
1— 85 sq. ft. 304 S.S., 100# PSIG, 400°F.
1— 80 sq. ft. 304 S.S., 75# PSIG, 350°F.
1— 50 sq. ft. 304 S.S., 100# PSIG, 400°F.
1— 31 sq. ft. 304 S.S., 100# PSIG, 400°F.

OTHER ITEMS

1—Complete oxygen plant, 170 tons day, 90-95% pure oxygen
3—Clark Air Compressors, gas engine drive, Model RA-8, 800 BHP, 2 and 4 stage
2—Clark Air Compressors, gas engine drive, Model MA, 150 BPH, 4-cylinder
2—Oliver 8' x 10' Monel, Rot. Vac. Filters
2—#12 Sweetland Filters 36 leaves.

COMPLETE DETAILS ON REQUEST: WIRE! PHONE! WRITE!

BRILL Equipment Company

4101 SAN JACINTO ST., HOUSTON 4, TEXAS — JU-6032

Arthur G. McKee Elects Two Vice Presidents to Board

Two vice presidents of Arthur G. McKee & Company have been elected to the board of directors, replacing two members who have retired.

Merrill Cox, a vice president in the Metals division, and Myran J. Livingston, vice president in charge of the Petroleum division, became board members at the annual meeting of stockholders. They replaced Wm. A. Haven and J. Krumhansl.

U. S. Rubber Shifts Preston

Thomas B. Preston, sales engineer with the Mechanical Goods division, United States Rubber Company, has been transferred to Los Angeles, where he will take charge of grinding wheels sales for the Pacific Coast.

Crane Vice President Dies

Charles R. Crane II, vice president and director of Crane Company, died recently in Chicago. He was 61. He had been associated with Crane 46 years.

STATISTICAL QUALITY CONTROL IS HERE!

Write for free copy of article on Statistical Quality Control in a Refinery, reprinted from February, 1954, *Petroleum Refiner*.

John T. Walter, Ph.D., Management Consultant

2311 Forest Drive, Pittsburgh 35, Pa.

■ Back issues Petroleum REFINER magazine Need all or any complete year from 1941 to 1946 inclusive. Address offer to Roger Genazzani, 55 West 42nd St., New York. Telephone WI-7-0656.

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Engineers

CHEMICAL ENGINEERS

Graduate chemical engineers with minimum 3 years process design experience in oil refinery or surface oil producing facilities. For New York office. Must be willing, however, to relocate in foreign operations at some future date.

CORROSION ENGINEERS

Foreign Service

Graduate Chemical or Metallurgical Engineer with minimum 10 years experience analyzing and resolving corrosion problems, 5 years of which must be in corrosion work relating to petroleum producing and refining materials and equipment.

Salaries for above positions commensurate with experience and training. Write giving full particulars regarding personal history and work experience. Please include telephone number.

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ARABIAN AMERICAN OIL COMPANY

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GLASSES & GASKETS

ALL SIZES TO FIT YOUR GAGES & VALVES
ERNST WATER COLUMN & GAGE CO.
Send for Catalog, LIVINGSTON, N. J.

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10" ELECTRICWELD LINE PIPE

10,000'-10¾" O.D. 40.48# Grade B Electricweld, Machine Cleaned, Straight, 40' DRL, ends beveled. Excellent like new condition, priced low prompt shipment Labadie, Missouri.

MID-STATES PIPE & SUPPLY CO.
Box 2534 Phone 2-9128 Tulsa, Okla.

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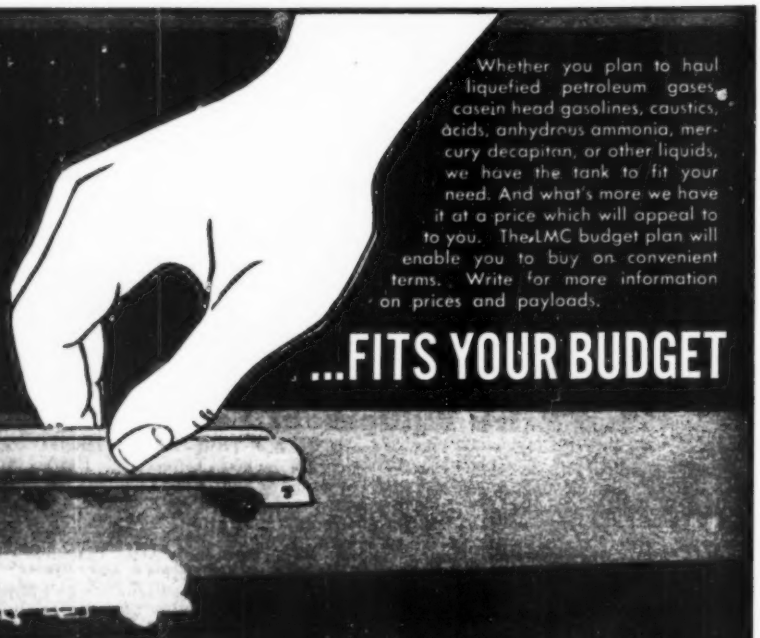
No matter what your liquid hauling problem, we can help you. Each tank trailer manufactured is designed specifically for a particular job. Each is engineered for the product . . . for the truck . . . for individual state highway and ICC requirements . . . and each is designed to provide a maximum pay load.



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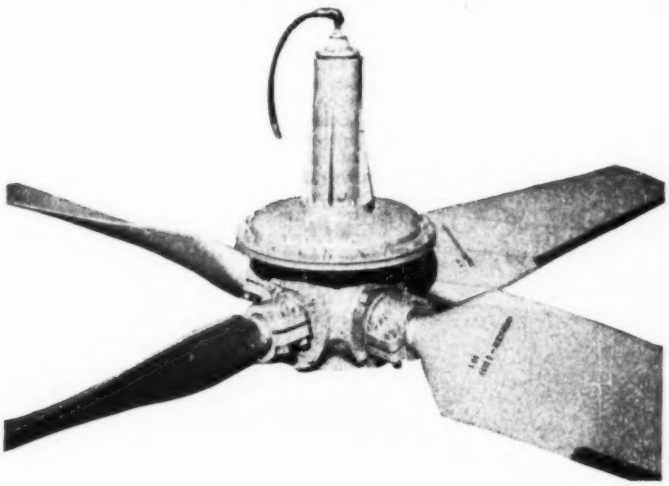
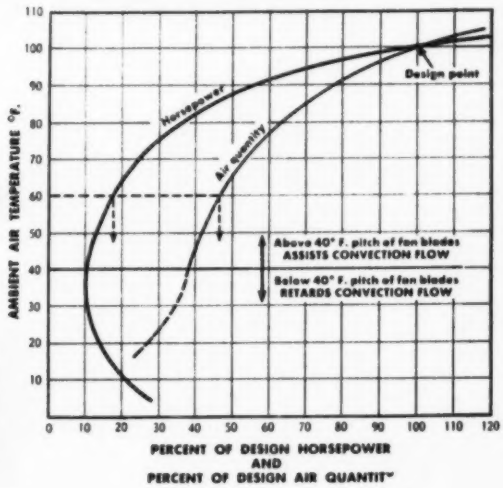
What's New in Equipment . . .





Variable Pitch Fan Controls . . .

. . . Outlet Fluid Temperature

For use in air-cooled units and water cooling towers, this auto-variable fan automatically changes blade pitch with minute changes in fluid temperatures.

Hudson Engineering Corporation is now making available to the refining and petrochemical industries its new Auto-variable pitch fan.

This new controllable pitch fan operates with standard pneumatic instruments supplying air at 0 to 15 psig. Fluid temperatures responsive to changes in air quantity may be controlled regardless of air temperatures, hot fluid temperature or heat load. Minute changes in cooler outlet temperatures immediately and automatically change pitch of fan blades increasing or decreasing the air flow across the cooler. The unique device is designed to:

- Accurately control temperature
- Effect major savings in power
- Reduce cost of control equipment
- Eliminate by-pass piping
- Prevent freezing even in extremely cold weather

The graph at the upper right illustrates performance characteristics obtainable through the use of the auto-variable pitch fans. In the example illustrated, the design requirements are to cool jacket water from 160 F. to 150 F. when ambient temperature is 100 F.; and to maintain constant outlet jacket water temperature of 150 F. regardless of decrease in ambient air temperature. As shown on the graph, when ambient temperature drops to 60 F., only 18 percent of design input horsepower to the fan and 47 percent of design air quantity is required. In the example illustrated, the fan blades turn into reverse pitch when ambient air temperature falls below 40 F. thus retarding convention flow of air. Auto-variable pitch fans maintain constant cooled stream temperatures even when ambient air temperature falls as low as minus 10 F. This control of the outlet temperature of the cool fluid is maintained constant without the necessity of shutters, louvers, or bypasses.

All moving parts of the control mechanism are completely enclosed and weather-proof. As found in three years of field testing experience, the auto-variable pitch fan gives trouble free operation with low maintenance.

Complete details on this new and unique product are available now. Simply . . .

Circle E1 on Postcard

Flexible Tubing

Flexible stainless steel tubing developed to convey a wide variety of corrosive liquids and gases at high temperatures is now available from American Brass Company, American Metal Hose Branch. This tubing is particularly recommended for applications involving vibration absorption, misalignment compensation, and connecting moving parts.

Complete details and specifications on this new stainless steel tubing are available now.

This item supplements American Brass Company data on pages 122-125 of The Refinery Catalog, 21st Edition.

Circle E2 on Postcard

Blow-Off Valves

Edward Valves, Inc., a subsidiary of Rockwell Manufacturing Company, is now manufacturing a redesigned line of blow-off valves with flanged or welding ends and bolted bonnets for 300-, 400-600-, 900-1500-pound sp classes plus

OPERATION BEST SILENCING!

Special Orders:

BURGESS-MANNING Exhaust and Intake

Snubbers installed for Tennessee

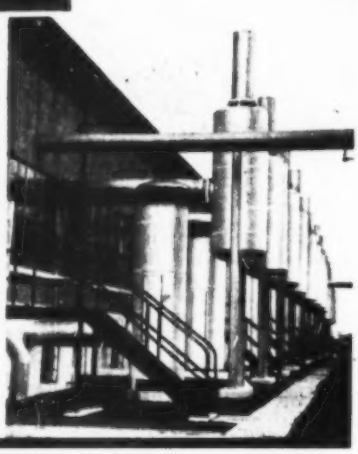
Gas Transmission Company

...engineered for this service.
...built to meet specific requirements.

OVER 100 SNUBBERS

Below: Exhaust snubbers and combination air filter snubbers engineered and built for four 1,600 h.p. and eight 2,000 h.p. gas engines at Station #1, Agua Dulce, Texas.

Above: Seven exhaust snubbers and seven combination air filter snubbers designed to meet the silencing requirements of seven 2,000 h.p. gas engines at Station #9, Bloomington, Texas.



Proper silencing is one of the keynotes of efficiency. That is the reason Tennessee Gas Transmission Company, operator of one of the major trunk line systems in the country, consulted Burgess-Manning Sound Engineers on their silencing requirements. Over one hundred snubbers were engineered and constructed by Burgess-Manning to eliminate the intake and exhaust noises at compressor stations along the Tennessee line.

For engineering data on your problem of noise control, call a Burgess-Manning Sound Engineer.

BURGESS-MANNING COMPANY

1203 DRAGON STREET
DALLAS, TEXAS

Sound Engineering

LIBERTYVILLE, ILL.
CHICAGO, ILL.

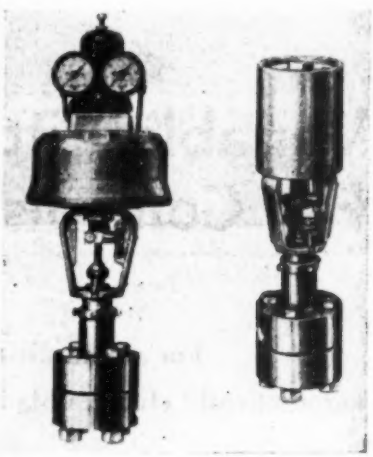
New Equipment...

the addition of welded bonnet blow-off valves with welding ends for 1500- and 2500-pound sp classes. The new line retains many Edward features such as interchangeability of parts, line contact backseats, condensate cooling chamber to protect the packing, and self-centering disk with swivel construction that allows stem to turn on the disk instead of the disk turning on the seat. Some of the new features include:

- Improved streamlining of interior body contours.
- Swing gland bolts for easier repacking.
- Stellited seating purposes for lower pressure classes.

A new catalog which illustrates, gives specifications, and describes this new line of blow-off valves is available now. Just...

Circle E3 on Postcard



High Pressure Valves

The newest addition to the line of high pressure control valves manufactured by Annin Company is the series 34 line of valves for pressures to 6000 psi and temperatures to 900 F. Illustrated above are models 3460, Domotor operated, and 3420, cylinder operated valves. Also available is Model 34 manually operated. These valves are available in sizes ½-inch and ¾-inch in a wide selection of body and trim materials and in both offset globe and angle bodies. A companion line, suitable for inlet pressures to 10,000 psi is also in production.

This item supplements Annin Company data on pages 140-141 of The Refinery Catalog, 21st Edition.

Circle E4 on Postcard

Magnetic Drive Pump

A new magnetically driven centrifugal pump is now available from Fostoria Pressed Steel Corporation. Known as the Dynapump, this fractional horsepower pump is driven by a rotating magnetic field instead of the usual drive

shaft. The motor and pump are in one sealed unit, there is no shaft seal or stuffing box. This type of construction makes possible a low cost, leak-proof unit that eliminates many of the difficulties encountered with conventional pumps. Standard units are of stainless steel and are recommended for pumping most fluids.

Complete information on the characteristics, specifications and performance of this new pump is available now. Just

Circle E5 on Postcard

Recording Controllers

A new line of instruments including potentiometric and a-c bridge recorders and recording controllers has been announced by the General Electric Company's Meter and Instrument department. Foremost among the new features of these instruments are the magnetic standard in the potentiometric system and a bridge-balancing unit in the a-c bridge system. Both models are available with either electric or pneumatic control, and are equipped with a unique centerless pointer that simplifies chart changing and leaves practically all of the chart exposed to view for easy reading.

The new magnetic standard eliminates dry cells, slidewires, and many moving parts found in conventional potentiometric instruments. Other advantages of the equipment include plug-in components, anti-backlash gearing, internal illumination, and an integral pen-inkwell assembly designed for automatic realignment.

Complete information on this new line of recording cotrollers is available now.

This item supplements General Electric Company data on pages 444-445 of The Refinery Catalog, 21st Edition.

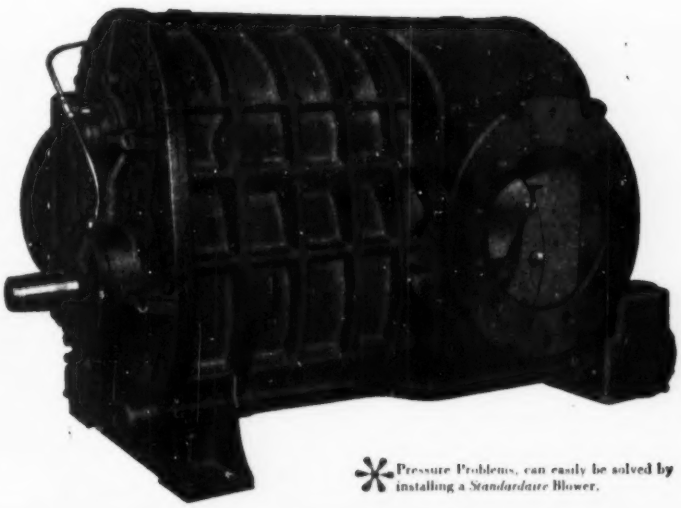
Circle E6 on Postcard

Aluminum Alloy

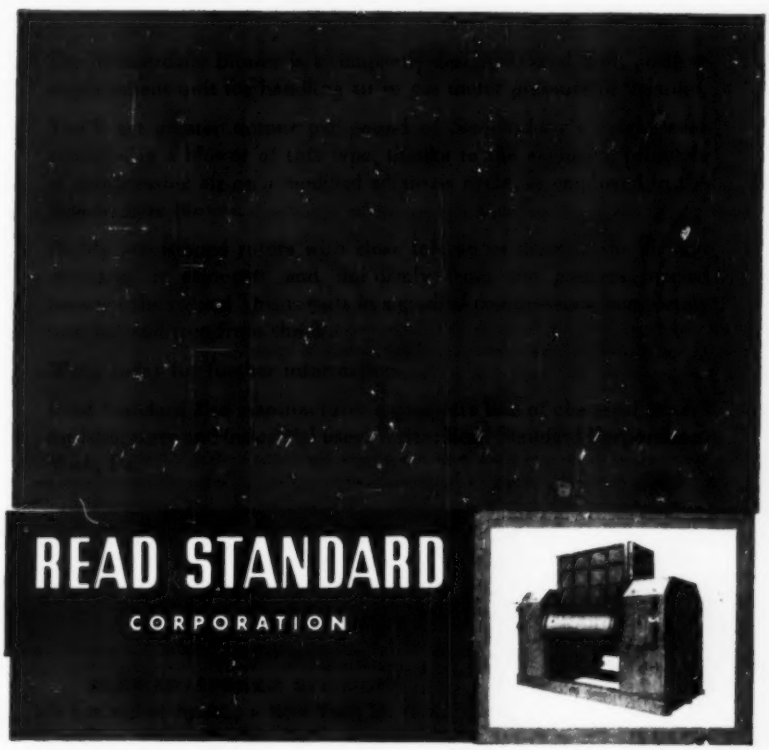
Aluminum Company of America now offers manufacturers and users of un-

SUFFERING FROM ?

Standardaire® Blowers
ARE YOUR SOLUTION



✱Pressure Problems, can easily be solved by installing a *Standardaire* Blower.



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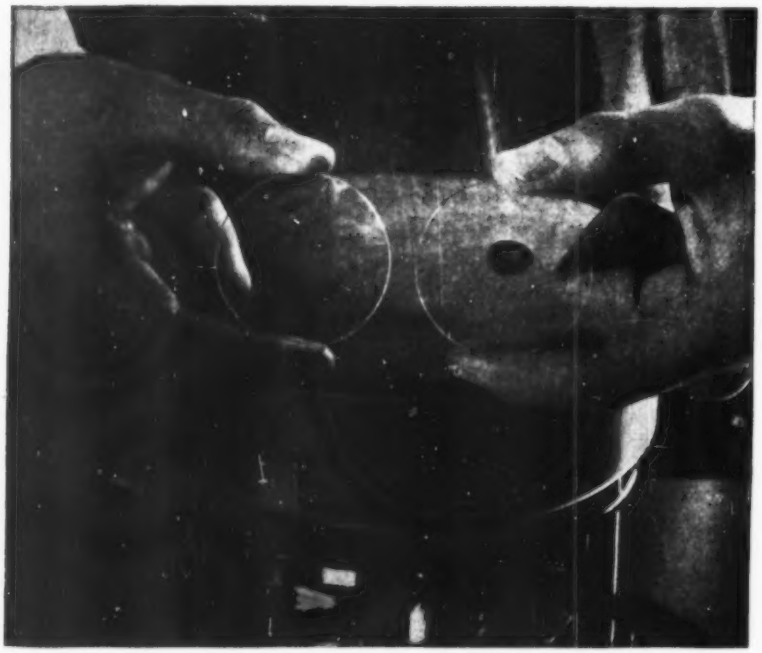
CORPORATION

Try this simple test yourself...



dbpc® gasoline antioxidant reduces formation of induction system deposits in engines

● These glass discs show the results of an evaporation test made on **dbpc** inhibitor and another widely-used gasoline antioxidant. The **dbpc** (di-tertiary-butyl-paracresol), after evaporating to dryness, left no residue at all. Additive "A," however, left a dark residual film.

Either of these antioxidants, combined with gasoline, passing through an automotive induction system, could react just as they have in this simple experiment.

dbpc also prevents the formation of gum in storage gasoline, another cause of induction system deposits. Moreover, it reduces harmful gum formation caused by gasoline as it passes through the intake system.

dbpc is safe and easy to handle—nontoxic and non-irritating. It is economical, highly soluble in gasoline, and is inert to extraction by the commonly used pipe line corrosion inhibitors.

It is also supplied in liquid form as Impruvol 33® antioxidant.

dbpc is only one of the many synthetic chemicals produced by Koppers. Others include Styrene Monomer, Polystyrene, Phthalic Anhydride, Divinylbenzene and Resorcinol. For further information, write to:

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New Equipment . . .

fired pressure vessels a valuable new construction material. This is due to the recent approval of aluminum alloy GR 40A by the Boiler Code committee of the ASME. Alloy GR 40A, (ASME designation), is commercially designated by Alcoa as A-54-S. This new alloy offers higher mechanical properties than any of the alloys previously approved for pressure welded vessels, i.e., 3S, 52S, 4S, etc. For this reason, allowable design stresses are higher. A-54-S maintains its strength better than other alloys at higher temperatures.

Complete details on this new alloy are available now.

This item supplements Aluminum Company of America data on pages 105-116 of The Refinery Catalog, 21st Edition.

Circle E7 on Postcard

Tubular Heat Exchangers

The Doyle and Roth Manufacturing Company is announcing a new line of tubular heat exchangers. This new line, designated standard "FC" coolers is especially recommended for cooling liquids or gases. They are assembled of standard parts offering the benefits of a specially designed unit, yet affording the advantages of mass production, low initial cost, quick delivery and available replacement parts. These new units are built to comply with the ASME Code, and are available in various combinations of ferrous and non-ferrous materials.

For complete information on this new line of heat exchangers, just . . .

Circle E8 on Postcard

Water Separator

A unique water separator is now being manufactured by Warner Lewis Company, a division of Fram Corporation. Named the Excel-So, it is designed to remove entrained water from light hydrocarbon products. This new separator employs a treated wood fiber packing. The packing is preferentially wet and water particles are coalesced into large droplets that settle rapidly. This principle combined with the unusual design of this equipment permits maximum water removal, high product flow rate and short residence time of the product

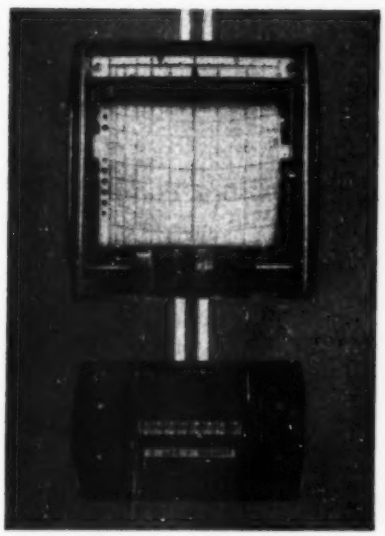
New Equipment . . .

in the separator drum.

Usually the units are constructed of carbon steel, but other alloys are available.

For complete information on this new separator, simply . . .

Circle E9 on Postcard



Integrator Unit

A new receiver-integrator for graphic panels has just been announced by Foxboro Company for use with its line of Consotrol instruments. A pneumatic-electric instrument, the new Type 224 Receiver-Integrator computes an accurate and continuous total of any process flow and operates a small counter located in the graphic display.

The integrator consists of two small, self-contained units: a remote counter and a flow receiver. The counter can be mounted on the front of a panel. It totalizes to eight digits and occupies only 3¼ inches by 5½ inches of panel space. The flow receiver unit, composed of a receiver bellows and a cam-switch assembly, is housed in a small metal box behind the panel. In operation, pneumatic measurement signals from the flow transmitter are received by the bellows which then positions the cam-switch mechanism. The cam-switch, in turn, produces an electric impuse to actuate the counter in precise and constant relation to the flow measurement.

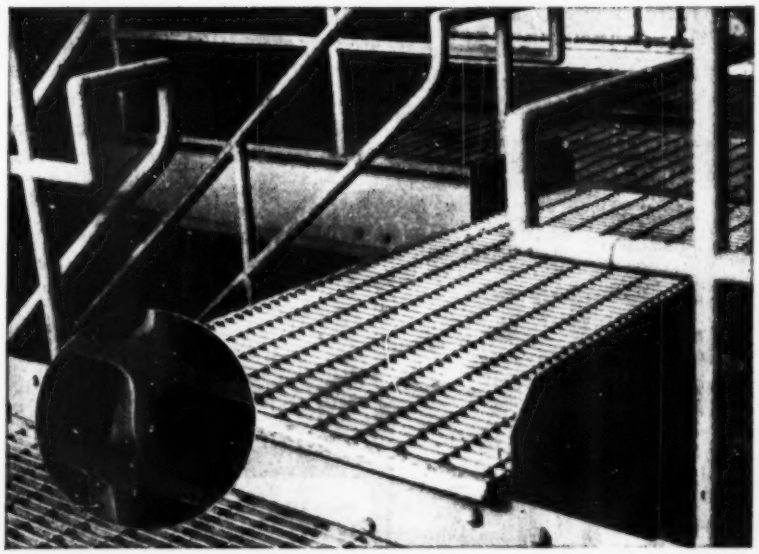
Integrators are available for uniform or square root scales to totalize minute, hourly, or daily rates.

For complete details on this new instrument simply . . .

Circle E10 on Postcard

Drum Coupler

OPW Corporation is announcing its new Molygate drum coupler designed to make valve changeover from one drum to another a quick, easy operation. This coupler allows discharge at any desired



Grating by BLAW-KNOX

where do **you** need

steel grating?

There must be lots of places where you are now using grating—floors, platforms, walkways, catwalks and stair treads, for example.

But how about other uses—such as some sturdy shelving or a fan guard—or for covering a dangerous open pit or a light well. Take a good look around your plant and you'll probably come up with several jobs, including perhaps a new use, as steel grating is adaptable to many applications.

Any time you want some help on a job related to grating, we'll be glad to hear from you.

Only BLAW-KNOX Electroforged® Steel Grating and Stair Treads —have these five exclusive features:

1. rigid one-piece construction—easy to install
2. all surfaces accessible—easy to paint
3. no sharp corners to clog—self-cleaning
4. maximum open area—for light and ventilation
5. non-slip twisted crossbar—safe footing

A short note will bring you a copy of new Bulletin No. 2365-R —a dimensional sketch will bring you a quotation.

BLAW-KNOX

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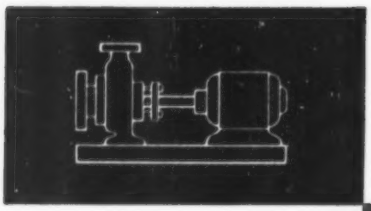
BLAW-KNOX EQUIPMENT DIVISION
GRATING DEPARTMENT

GRATING APPLICATIONS: floors • platforms • walkways • catwalks • stair treads • fan guards • shelving • and many other uses, both outdoors and indoors, for versatile steel grating.

For more data on advertised products, use Readers' Service Cards, last page.



What do pump manufacturers and pump users say about Sealol-Flexibox Mechanical Shaft Seals? Do these shaft seals stand up? Do they prevent leakage under rigorous conditions? Are they safe? Let these typical cases speak for Sealol-Flexibox . . .

LET'S GET DOWN TO CASES...

MAY 4, 1953

Leading pump manufacturer orders eleven Sealol-Flexibox Seals for following applications: Butane and lighter fractions at 580 psig.; liquified petroleum gases at 190 psig.; ethylene and ethane at 480 psig.; rich oil at 560 psig.; liquified petroleum gases at 150 psig.; caustic solution at 585 psig.

NOV. 3, 1953

Major oil refinery "enthusiastic" over performance of Sealol-Flexibox Seal on butane pump (1¾"shaft) at pressures to 400 psig.

MAY 16, 1953

World famous petroleum processing and refining organization standardizes on Sealol-Flexibox Mechanical Shaft Seals for new and existing pumps.

FEB. 11, 1953

Refinery so satisfied with performance of Sealol-Flexibox Seal on propane pump operating at 263 psig. they are now substituting Sealol-Flexibox Seals for those presently fitted on other pumps.

JUNE 9, 1953

Oil refinery reports very satisfactory performance of Sealol-Flexibox Seals handling propane at pressures as high as 420 psig. suction pressure — and 555 psig. delivery pressure.

APRIL 10, 1953

Refinery reports highly satisfactory performance of approximately 60 Sealol-Flexibox Seals in continuous operation since the summer of 1951, handling a large variety of fluids, including Dowtherm at 425°F.

SEALOL

Sealol Corporation, 13 Willard Ave., Providence 5, R. I. Chicago, Cleveland, Los Angeles, Houston, Philadelphia, Kansas City, Charleston, W. Va.

THE BALANCED PRESSURE SEAL

New Equipment . . .

angle. The winged swivel securely attaches coupler to drum by hand and eliminates wrenching, pounding and stripped threads. Heavy hand lugs, offset for easy gripping, also protect faucets from damage. Some of the features of this new coupler are:

- "O" ring seal.
- Heavy spring-wire lock provides swivel.
- Straight through design allows full 2-inch rate of flow.

To get the information you need on this new product, simply . . .

Circle E11 on Postcard

High Pressure Pumps

Milton Roy Company has announced the Hy-Roymetric pump, a new flow control instrument for pressures up to 50,000 psi and capacities to 1350 gph. Available in a wide range of materials, the pump may be powered by air or electric motor. Capacity regulation is accomplished manually or automatically through driver speed variation. Stroke length is adjusted from 0 to 100 percent while the pump is operating for further capacity control. Among the features of these new pumps:

- New crankshaft support.
- Shortened plunger to eliminate overhung load.
- Outside end packing for easier replacement.

Complete details may be obtained now.

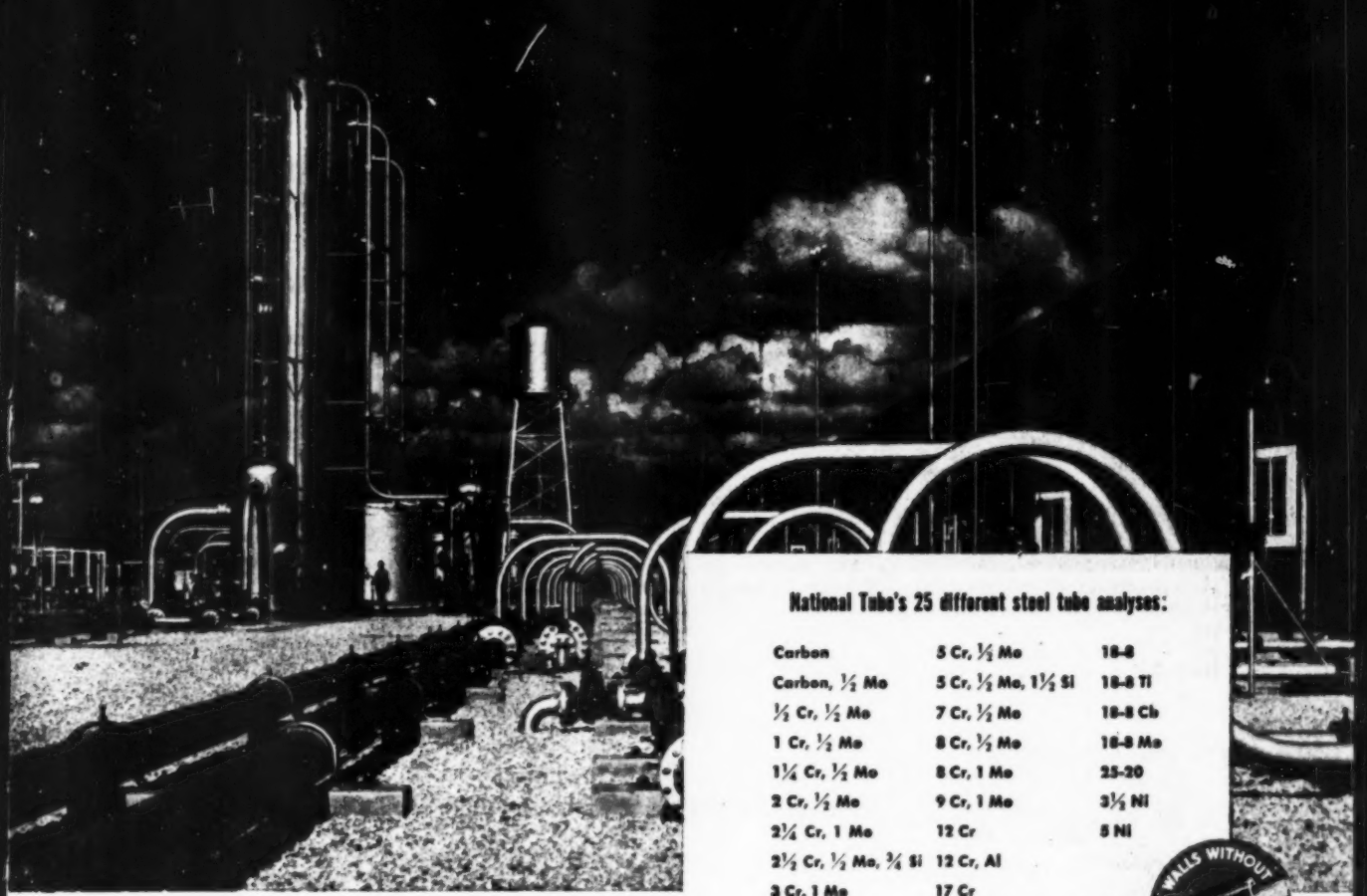
This item supplements Milton Roy Company data on page 597 of The Refinery Catalog, 21st Edition.

Circle E12 on Postcard

EXPANDING-SEAL FILLING CONNECTOR

Sealing Plugs

Mechanical Products Corporation is introducing "Quick-Seal" expanding plugs and connectors. These plugs and connectors are made for standard pipe openings from ¼-inch to 4-inch and are recommended for low pressure testing. Special sizes and adaptations can be



National Tube's 25 different steel tube analyses:

Carbon	5 Cr, ½ Mo	18-8
Carbon, ½ Mo	5 Cr, ½ Mo, 1½ Si	18-8 Ti
½ Cr, ½ Mo	7 Cr, ½ Mo	18-8 Cb
1 Cr, ½ Mo	8 Cr, ½ Mo	18-8 Mo
1¼ Cr, ½ Mo	8 Cr, 1 Mo	25-20
2 Cr, ½ Mo	9 Cr, 1 Mo	3½ Ni
2¼ Cr, 1 Mo	12 Cr	5 Ni
2½ Cr, ½ Mo, ¾ Si	12 Cr, Al	
3 Cr, 1 Mo	17 Cr	

WALLS WITHOUT WELDS

25 different answers

to the problems of corrosion, temperature and exposure

NATIONAL Tube has developed 25 different steel tube analyses, each for the specific purpose of overcoming actual conditions of corrosion, oxidation, temperature, pressure and exposure. All of these analyses have been thoroughly tested in refinery service, so that we know exactly what each one should do. Other chemical compositions are also available in tubular products, and a wide variety of high temperature problems are now under study.

If you're having difficulty deciding on what analysis *you* need for a particular application, get in touch with us. We'll make a study of your installation conditions and recommend the best pipe or tubing for the job. Our engineers are specialists in their line and anxious to help you. What's more, they are backed-up by National Tube's "experience file"—a collection of authentic case histories built up over 60 years of working out the most difficult tubing problems for our customers.

No matter what your tubing problem is, we'd like the opportunity to help you. Look over the 25 analyses listed here. Then, before you make a definite decision on new pipe or tubing, consult our engineers—at no obligation. They'll recommend the analysis that will do the most efficient job at the least expense to you. Write to: National Tube Division, United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pa.

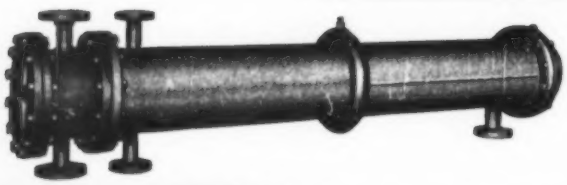
NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
(Tubing Specialties)

COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS • UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS **NATIONAL SEAMLESS PIPE AND TUBES**

UNITED STATES STEEL

THE ANSWER TO YOUR EXCHANGER PROBLEMS MAY BE HERE

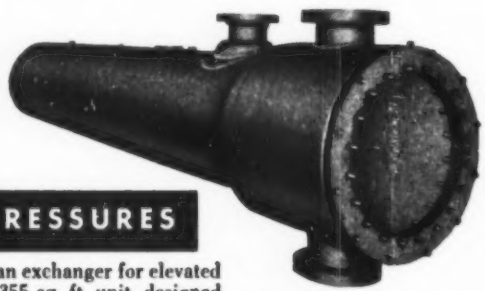


SPECIAL MATERIALS

Perhaps you require special materials of construction, as in the case of this straight tube — fixed tube sheet condenser with compensating shell expansion member. All materials of construction are aluminum except for the steel channels and the backing flanges. All aluminum welds were effected by inert gas shielded arc process . . . or, should you require stainless steel, copper, nickel or Hastelloy construction, our experience assures satisfactory construction.

SPECIAL DESIGNS

Perhaps you require special design techniques as in the case of this double tube sheet exchanger which employs independent tube sheets for each circuit, thereby preventing even a remote possibility of inter-leakage between shell and tube circuit fluids. Our engineering organization is thoroughly experienced in designing exchangers for difficult operating conditions.



ELEVATED PRESSURES

Perhaps you require an exchanger for elevated pressures like this 3,355 sq. ft. unit, designed for a tube side pressure of 900 p.s.i.g. We are regularly manufacturing shell and tube units for pressures up to 3,000 p.s.i.g. and shell and coil units for pressures in excess of 5,000 p.s.i.g.

Whitlock

For recommendations write The Whitlock Manufacturing Company, 75 South Street, Hartford 10, Conn.

Designers and builders of bends, coils, condensers, coolers, heat exchangers, heaters, piping, pressure vessels, receivers, reboilers.

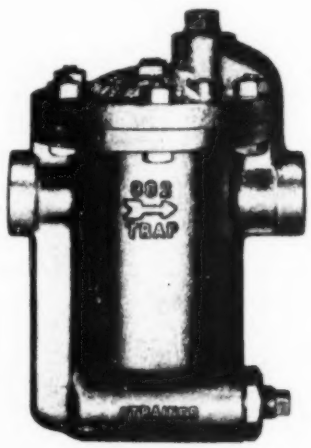
New Equipment . . .

supplied upon order.

Employing a cam-lever action to expand and draw a flanged rubber bushing against the inside wall and face of an opening, "Quick-Seal" test plugs and fitting connectors are designed to provide an effective double sealing action in split seconds. Openings may be closed and pressure lines adapted for air or hydrostatic testing of tanks, boilers, barrels, drums, radiators, etc. "Quick-Seal" plugs and connectors are made to be equally effective in all types of plain or threaded openings, including flanged, spudded, or drawn openings, blind hole fittings, couplings, and deep openings. Operation of the units is extremely simple and fast. Simply insert the unit into the opening and depress the cam handle. Seals on all units are adjustable for amount of expansion and holding tension. Filling connectors are tapped with standard pipe inlets for adapting pressure lines.

Complete information on this new item is available now, simply . . .

Circle E13 on Postcard



Integral Strainer Trap

Armstrong Machine Works has added to its line of integral strainer steam traps a new larger model designated as No. 882. The new trap is particularly recommended for use where dirt and scale conditions are bad. The No. 882 is made in capacities ranging from 1300 to 2200 pounds of condensate per hour and a maximum operating pressure of 250 psig. This new trap has a body of fine grained cast semi-steel, while the internal parts are of chrome and stainless steels. Two maintenance features of this new trap are the use of straight threads on the strainer bushing and the inclusion of a copper asbestos gasket between the bushing and the body to prevent rusting-in or "freezing."

Complete details on this new strainer trap are available now.

This item supplements Armstrong Machine Works data on page 139 of The Refinery Catalog, 21st Edition.

Circle E14 on Postcard

Another Efficient

Viking pumps are giving top performance wherever used in the petro-chemical industry. The above installation is serving a major pipeline company and consists of: a Viking Model L-124, Size 2" Standard fitted heavy duty rotary pump mounted on welded steel skids and direct connected through 7 F Falk coupling to a 2 cylinder Air Cooled Power Unit.

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  price $12.00
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Pipe Half Soles with Full Value!

HERE are the Dollinger pipe patches that make pipe repair easy and economical. All edges are machine sheared for perfect fit, and beveled for smooth joints.

Dollinger pipe patches are available for immediate shipment in standard sizes and thicknesses; and we can make prompt delivery on patches fabricated to your order.

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AROUND THE WORLD

For more than 50 years quality producers of structural steel and plate steel.

JOHN DOLLINGER, JR., INC.
BEAUMONT, TEXAS

For more data on advertised products, use Readers' Service Cards, last page.

Hartzell Cooling Tower Fans Handcuff These Thugs

Corrosion, abrasion and vibration can't get the best of a fan with Hartzite plastic blades. That's why these thugs steer clear of a cooling tower or heat exchanger equipped with Hartzell fans.

Hartzite blades absorb vibration, resist abrasion and are unaffected by most industrial acids, mild alkalies and weather. Even when the surface of the blade is damaged, you're not in trouble—the interior has the same high resistance to corrosion and mechanical damage.

Nearly every Hartzell fan installed since the introduction of the Hartzite plastic blade in 1941 is still in service today. Where one Hartzell has been installed on a battery of cooling towers or heat exchangers, "Hartzell" is invariably specified as additional fans need replacement.

For more details on how Hartzell, "the" cooling tower and heat exchanger fan of the petroleum industry, can handcuff the cooling tower thugs who have been causing you trouble, write today for your free copy of Bulletin A-111.

HARTZELL *propeller fan co.*

Div. of Castle Hills Corp.

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Company _____

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If student, check here for special information ☐

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PIQUA, OHIO

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ENGINEERING OFFICES IN PRINCIPAL CITIES

What's New in Manufacturers' Literature

For more data on New Equipment or copies of Catalogs and Literature reviewed in this issue, use the Reader Service postcards just inside the back cover and facing the Advertisers Index. Simply circle code numbers of items desired—sign and mail card. Requests are transmitted to the manufacturer as soon as received by us for mailing of desired information directly to you.

V-Belt Slidefilms

The second group in the series of educational 35 mm slide films for industry is now available through Allis-Chalmers General Machinery division district offices. The three slide films are on the subject of V-belt drives and each run about 20 minutes. The first film, in color, covers the engineering principles that are basic in every V-belt drive application. The second concerns itself with with the installation and maintenance of multiple V-belt drives. The third tells how to check characteristics to find the best type of drive and then how to engineer it to do the job.

These films are prepared for such audiences as industrial maintenance men, plant engineers, design engineers and engineering students. For information regarding showings of any of these slide films, just

Circle E15 on Postcard

Valve Catalog

Catawissa Valve and Fittings Company is now making available to the refining and petrochemical industries their new Catalog No. 11. Thoroughly illustrated, this catalog gives complete details and specifications on the company's complete line of valves and unions. It also includes a section of methods and materials of construction and a test data chart. To receive your copy of this catalog, simply

Circle E16 on Postcard

Chemical Cleaning

A new bulletin on maintenance cleaning of air conditioning and refrigeration systems with chemical solvents has recently been issued by Dowell, Inc. This bulletin describes several case histories of various types of fouling and cleaning. To get your copy, simply

Circle E17 on Postcard

Water Treatment

Rohm & Haas Company has compiled a 24-page booklet entitled, "If You Use Water." This booklet explains the variations, methods of operation, equipment required, and types of water produced by more than a dozen important water treating processes, which are serving refining and petrochemical industries today. Illustrated liberally with two-color flow diagrams, the booklet discusses the fundamentals of the three major classifications of industrial water treatment based on ion exchange: softening, dealkalization, and deionization. Under each of these classifications, the booklet presents the major process variations. The advantages of the various water treatment methods are discussed and interpreted in terms of the specific applications. Your copy of this booklet is available now. Simply

Circle E18 on Postcard

Organic Acids

A new booklet, "Organic Acids," has just been published by Carbide and Carbon Chemicals Company, a division of Union Carbide and Carbon Corporation. This booklet discusses in details the eight organic acids that are sold in commercial quantities by the company. It tells of their uses in many industries and gives their physical properties, specifications, shipping data and constant boiling mixtures. The sections on physical properties and specifications will be helpful in suggesting uses and in determining proper handling and storage procedures.

An important feature of this booklet is an entire section devoted to the specifications and test methods used for these organic acids. These laboratory control tests comprise some of the standard ASTM methods, as well as new methods that have been specially developed in the company's own laboratories. To receive your copy of this informative booklet, simply

Circle E19 on Postcard

Butterfly Valve Bulletin

Minneapolis Honeywell Regular Company has just issued a new bulletin on its Continental butterfly valve bodies and the new Honeywell series 800 diaphragm motor operators. This bulletin contains complete tables of allowable pressure differentials and specifications on both of these items. The bulletin replaces the company's catalog number 1700. Copies are available now. Simply

Circle E20 on Postcard

Fittings Bulletin

Dekoron Tubing division of Samuel Moore and Company is announcing a bulletin on the company's new line of Dekoron E-Z tube fittings. These fittings are designed especially for use with Dekoron plastic instrument tubing and Impervapak Polly-Cor, an unusual type of multiple tube instrument line harness. The bulletin is punched for insertion in standard three-ring binders and is illustrated, in color, with exploded and section views and gives part number and dimension data for ordering. To get your copy of this most informative bulletin, just

Circle E21 on Postcard

Spectrophotometer

A two-color illustrated brochure showing features and advantages of the double beam Model 21 infra red spectrophotometer has just been published by Perkin-Elmer Corporation. The bulletin describes the Model 21 as the fastest, most advanced and efficient infra-red spectrophotometer available for analytical research on organic compounds. In addition to the description of the many advantages of the new model, complete specifiications are also given. Copies of the new brochure are available now. Just

Circle E22 on Postcard

Switchgear Bulletin

A new bulletin on low voltage switchgear has just been published by Continental Electric Equipment Company. In addition to describing the company's complete line of low voltage switchgear, this bulletin contains a large section on specifications and dimension drawings. It is designed as a manual for everyone interested in specification and application of low voltage switchgear. To receive your copy of this informative 36-page illustrated booklet, just

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Raschig Ring Bulletin

Johns-Manville has just issued a four-page folder entitled, "J-M Raschig Rings." This bulletin describes split metal Raschig Rings which can be made from any required metal in diameters from one quarter inch to three inches. This bulletin also includes data on number of rings per cubic foot, square feet surface area per cubic foot, percent voids, relative efficiency, equivalent spherical diameter, and weights in pounds, either per thousand rings or per cubic foot. This folder should be of value to engineers who are designing and constructing new towers and for engineers who specify packing for existing towers. To receive your copy, simply

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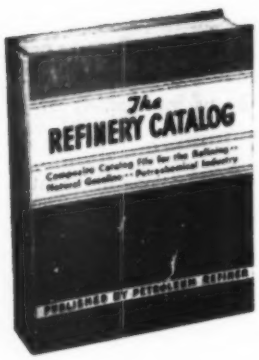

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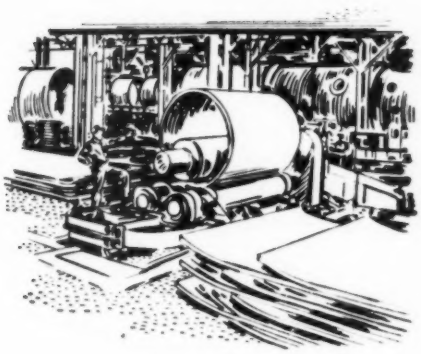


• Within a few hours after loading was completed at Wyatt's Dallas plant, this Platforming Unit was at the refinery site.

It's another instance of doing things the Wyatt Way.

The quicker the delivery, the sooner the Profit.

MANUFACTURERS AND ERECTORS SINCE 1913

Plate 864

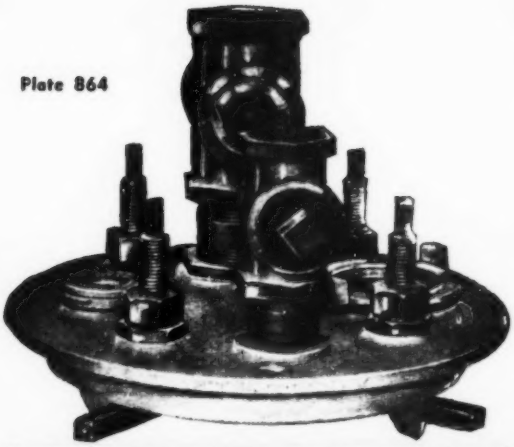
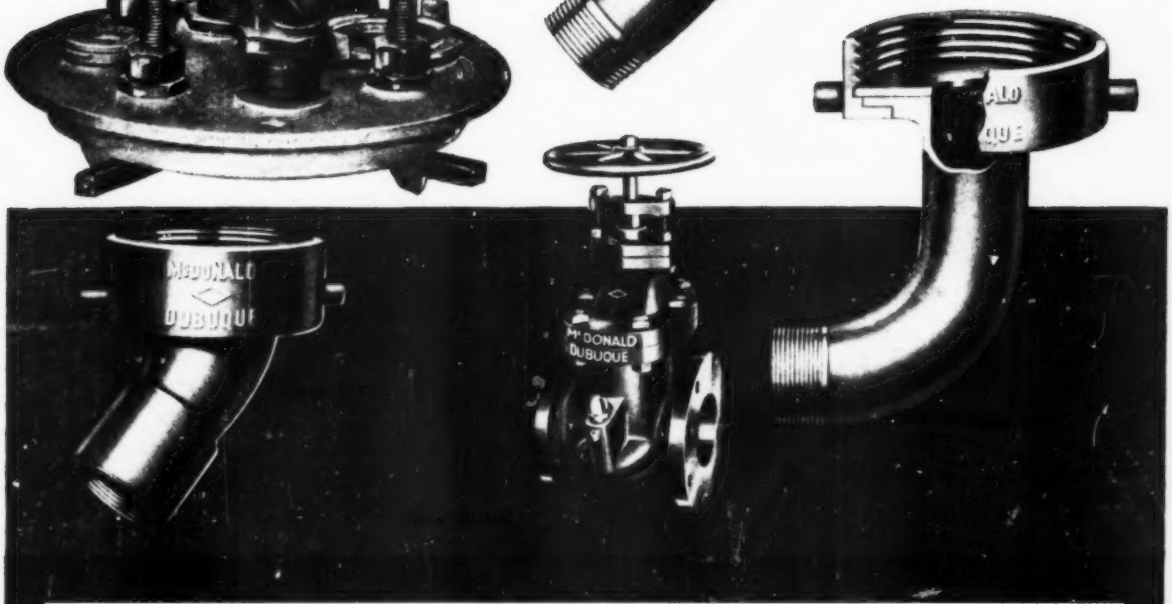


Plate 807-A



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From products of simplest design to the most intricate planning on the drawing board, following through to the ultimate of years of service McDonald equipment shows its ability to take it. Built into our equipment is not only ruggedness but also the newest and best features which men in the field tell us they want and need. It's toward this end that our engineers and production men are constantly working.

A good example of this is Plate 864, illustrated above. This cover is used when loading tank cars with gasoline — reduces evaporation losses — eliminates danger of sparks - - permits loading rain or shine. Made of aluminum — permits easy handling by one man. Covers are equipped with "Peep Hole Glasses" in order that contents of car may be watched while loading.

Also produced by McDonald for tank car work are Plates 807, 807-A and 917. As you can see, the difference is the 90 and 45 degree angles, whichever you desire, with Plate 917 featuring female outlet threads. All 3 of these Tank Car Reducer Couplings are made of bronze and come equipped with a composition gasket and forged steel spanner wrench. They are offered in sizes from 5 x 2 inches up to 5 x 4 inches, with Plate 917 in sizes from 5 x 2 inches to 5 x 3 inches.

Also illustrated is Plate 860-N, a 4" flanged, non-rising stem Expansion Relief Gate Valve. When pressure in a line builds up, the disc in the by-pass opens, allowing the pressure in the line to equalize itself with that in the tank. Valve is set at 20 pounds pressure but this may be set as desired.

For further information on any of the above items or on our complete line, please write the A. Y. McDonald Mfg. Co., Dubuque, Iowa.

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